PUBLIC DOCUMENT . . . . No. 34.

TWENTY-NINTH ANNUAL REPORT

OF THE

STATE BOARD OF HEALTH

OF

MASSACHUSETTS.

BOSTON:
WRIGHT & POTTER PRINTING CO., STATE PRINTERS,
18 POST OFFICE SQUARE.
1898.

MEMBERS OF THE BOARD.

1897–1898.

HENRY P. WALCOTT, M.D., *Chairman*, ...	OF CAMBRIDGE.
JAMES W. HULL, ...	OF PITTSFIELD.
CHARLES H. PORTER, ...	OF QUINCY.
JULIAN A. MEAD, M.D., ...	OF WATERTOWN.
HIRAM F. MILLS, C.E., ...	OF LAWRENCE.
FRANK W. DRAPER, M.D., ...	OF BOSTON.
GERARD C. TOBEY, ESQ., ...	OF WAREHAM.

Secretary.

SAMUEL W. ABBOTT, M.D.

Engineer.

X. H. GOODNOUGH, C.E.

CONTENTS.

GENERAL REPORT.

The following report of the State Board of Health comprises an account of its general work during the year ending Sept. 30, 1897, and of that which relates to Water Supply and Sewerage for the calendar year 1897.

This first portion, paged in Roman numerals, contains a condensed statement of the work done under the provisions of the laws defining the duties of the Board.

To this is appended the report, in brief, already presented to the Legislature by the joint board consisting of the Harbor and Land Commissioners and the State Board of Health, upon the restoration of Green Harbor in the town of Marshfield.

The second part of the report, paged in Arabic figures, contains the fuller details of the work of the Board, under the acts relating to water supply and sewerage, food and drug inspection and the reporting of infectious diseases.

The following members comprised the Board in 1897: —

Henry P. Walcott, *Chairman.*

Frank W. Draper.	Gerard C. Tobey.
Hiram F. Mills.	Charles H. Porter.
James W. Hull.	Julian A. Mead.

No changes have taken place in the membership of the Board during the year.

Infectious Diseases.

In the last annual report a brief table was presented, in which it was shown that there has been a general decrease, with a fair degree of uniformity, in the death rate from the principal infectious and preventable diseases in Massachusetts during the past forty years. From a maximum of 93 deaths per 10,000 living from these causes in the five-year period 1861–65 there had been a fall to 47.1 per 10,000 in 1895, or but little more than one-half. In 1896 there was

a slight rise to 48.1, but the returns thus far received from cities and towns for the year 1897 indicate a considerable decrease from the figures of 1896.*

Small-pox.

The outbreaks of small-pox which occurred in the State in 1897 were limited to the first half of the year, and the cases which were reported to the Board were 18, 10 of which occurred in Boston, 2 in Somerville, 2 in Holyoke, 2 in Cambridge, 1 in New Bedford and 1 in Gloucester. The particulars in regard to these cases are detailed in the following table: —

Cases of Small-pox reported to the State Board of Health in 1897, under the Provisions of Chapter 138 of the Acts of 1883.

No.	Date.	Place.	Nationality.	Occupation.	Age.	Sex.	Previously Vaccinated.	Number of scars.	Died.
1	Apr. 26	Somerville, .	United States,	Carriage worker, . .	29 years.	M.	-	-	-
2	Mar. 30	Holyoke, .	French Canadian.	- -	9 years.	F.	-	-	-
3	Apr. 16	New Bedford,	Portugal, .	Seaman, ...	27 years.	M.	No.	-	-
4	Mar. 27	Holyoke, .	French Canadian.	- -	10 years.	F.	Yes.	1	-
5	May 8	Boston, . .	Ireland, . .	Car cleaner, . . .	26 years.	M.	Yes.†	1	-
6	May 9	Boston, . .	Ireland, . .	Car cleaner, . . .	22 years.	M.	Yes.†	2	-
7	May 9	Boston, . .	Ireland, . .	Waiter, ...	26 years.	M.	Yes.†	1	-
8	May 9	Boston, . .	Ireland, . .	Housewife, . . .	24 years.	F.	Yes.†	2	-
9	May 14	Boston, . .	Ireland, . .	Stevedore, . . .	29 years.	M.	-	-	-
10	May 14	Boston, . .	United States,	- -	6 mos.	F.	No.	-	-
11	May 17	Boston, . .	England, . .	- -	25 years.	F.	Yes.†	1	-
12	May 20	Boston, . .	England, . .	Housewife, . . .	28 years.	F.	-	-	-
13	May 22	Somerville, .	British Provinces.	R.R. ticket agent, . .	17 years.	M.	No.	-	1
14	May 22	Boston, . .	United States,	Board of Health employee, disinfector.	40 years.	M.	Yes.	-	-
15	June 1	Boston, . .	United States,	Laborer, . . .	32 years.	M.	-	-	-
16	June 3	Cambridge, .	British Provinces.	Mechanic, . . .	44 years.	M.	Yes.‡	-	1
17	June 10	Gloucester, .	United States,	Housewife and nurse, .	32 years.	F.	-	-	-
18	June 14	Cambridge, .	United States,	Boarding-house keeper,	42 years.	F.	Yes.§	2	1

* The causes of death embraced in the term "principal infectious and preventable diseases," as here employed, are small-pox, measles, scarlet-fever, diphtheria and croup, typhoid fever, cholera infantum, consumption, whooping-cough, dysentery and child-birth.

† In infancy and when exposed. ‡ Only at time of exposure as far as can be learned.

§ In infancy.

The following table presents the facts in regard to vaccination, in its relation to the fatality of the disease, for the ten years 1888 to 1897 inclusive.

Cases and Deaths in the Vaccinated and Unvaccinated in Massachusetts (1888-97), Ten Years, by Ages.

Ages.	Vaccinated.		Unvaccinated.		Doubtful.		Total.	
	Cases.	Deaths.	Cases.	Deaths.	Cases.	Deaths.	Cases.	Deaths.
0 to 1 year,	-	-	18	9	1	-	19	9
1 to 5 years,	4	-	36	6	-	-	40	6
5 to 10 years,	2	-	17	-	1	-	20	-
10 to 15 years,	14	-	6	-	2	-	22	-
15 to 20 years,	18	1	19	5	6	2	43	8
20 to 30 years,	58	3	34	10	15	4	107	17
30 to 40 years,	18	3	15	5	3	1	36	9
40 to 50 years,	17	2	3	3	3	-	23	5
Over 50 years,	9	-	-	-	3	1	12	1
Unknown,	3	-	1	-	4	-	8	-
Total,	143	9	149	38	38	8	330	55

From the foregoing table it appears that the fatality of small-pox in the vaccinated was 6.3 per cent. Among the unvaccinated it was 25.5 per cent. The fatality of all cases, vaccinated, unvaccinated and doubtful, was 16.7 per cent.

It also appears that no vaccinated child under one year old was attacked with small-pox, while 18 unvaccinated infants were attacked, and 9 of these, or 50 per cent., died of the disease.

Among vaccinated children under fifteen years of age there were 20 attacks and no deaths.

Among unvaccinated children under fifteen years old there were 77 attacks and 15 deaths, or 19.5 per cent.

Among vaccinated adults, or persons over fifteen years old, there were 120 cases and 9 deaths, or 7.5 per cent.

Among unvaccinated adults there were 71 cases and 23 deaths, or 32.4 per cent.

It is also worthy of note that 42 school children, or children of school ages (five to fifteen years) were attacked, and of this number, 23, or more than half, were unvaccinated. Out of this whole num-

ber (42) there were no deaths. This being the period of life in which the power to resist fatal attacks of disease is greatest.

Out of the whole number of adults (120) who were recorded as having been vaccinated, 78, or 65 per cent., were recorded as having been vaccinated in infancy only; and it is safe to presume that the 9 deaths of adults occurred among this class exclusively.

It also appears that all of the deaths of the vaccinated, 9 in number, occurred among adults, while among the unvaccinated, 15 deaths, or nearly 40 per cent. of the deaths of the unvaccinated, occurred among children under ten years of age.

These facts show unmistakably the saving of child life by means of vaccination.

Small-pox in Other States.—If any conclusions can be maintained with reference to the prevalence of small-pox in other parts of North America, from the occasional reports which have been received in compliance with the resolutions adopted at Toronto in 1886, it would appear that small-pox prevailed very slightly in 1897. The following are the only cases which have been reported during the year 1897, under these resolutions:—

In Connecticut, one case in February and one in December.
In New York, two cases, one in February and one in March.
In Michigan, four cases in October.
In Ontario, one case in August.
In Quebec, thirty cases in the last half of the year.

Notice was also received from the immigration office at the port of New York of the existence of cases of small-pox on the steamers "Southwick," "Phenicia" and "Edam," and information was forwarded to the health officers of each of the cities and towns in Massachusetts to which immigrants from these ships were destined. This enabled the health authorities of these places to keep those persons under surveillance and to vaccinate all persons in the houses where they were lodged.

Typhoid Fever.

The death rate of any community from typhoid fever is a most important index of the sanitary condition of such community. While a high death rate from this cause, continuing for a short period and affecting a limited portion of the community, may be due to an infected milk supply, or some other unsanitary local condi-

tions, a persistently high typhoid death rate, recurring year after year, usually indicates a polluted water supply. This fact has been very clearly shown in the reports of the past ten years with reference to the cities of Massachusetts.

For convenience of reference the table of death rates of cities from this cause, which was published in the twenty-eighth annual report (1896), is repeated in this report, with the added figures for 1897, so far as they are obtainable at the date of publication. The arrangement is the same as that which was presented last year, that is, by five-year periods, the cities having the highest typhoid death rate being placed at the top of the list in each period, and the others following in their order, those having the lowest rate being placed at the bottom.

The sum of the deaths from typhoid fever in these cities in 1897 was less by 61 than that of 1896 in the same cities, and the death rate was reduced from 2.90 per 10,000 to 2.47.

Deaths and Death Rates per 10,000 Inhabitants from Typhoid Fever in Massachusetts Cities, 1871-95.

	1871-1875.			1876-1880.			1881-1885.			1886-1890.			1891-1895.	
Holyoke,	157	23.3	Holyoke,	77	8.1	Holyoke,	159	12.8	Lowell,	396	11.2	North Adams,	74	8.4
Springfield,	214	14.8	Lawrence,	122	6.6	Chicopee,	48	8.4	Lawrence,	233	11.2	Lawrence,	187	7.7
Chicopee,	63	12.6	Chicopee,	35	6.5	Lowell,	243	7.9	North Adams,	64	8.9	Lowell,	294	7.3
Lawrence,	190	11.9	Fall River,	152	6.4	North Adams,	43	7.6	Chicopee,	43	6.7	Chicopee,	50	6.6
Lowell,	221	9.8	Malden,	31	5.4	Lawrence,	144	7.4	Fall River,	209	6.4	Woburn,	33	4.8
Fall River,	176	9.8	Springfield,	86	5.3	Fall River,	174	6.6	Holyoke,	105	6.6	Newburyport,	29	4.1
Pittsfield,	56	9.6	Worcester,	131	4.9	Springfield,	117	6.6	Marlborough,	32	5.2	Springfield,	97	4.1
Brockton,	43	9.2	Haverhill,	40	4.8	Taunton,	59	5.3	Quincy,	37	5.1	Quincy,	37	4.0
Chelsea,	86	8.7	Salem,	61	4.6	Lynn,	109	5.2	Pittsfield,	40	5.0	Salem,	63	3.9
Northampton,	46	8.7	Newburyport,	31	4.6	Haverhill,	52	5.2	Haverhill,	59	4.8	Fall River,	154	3.8
New Bedford,	99	8.4	Pittsfield,	29	4.5	Boston,	952	5.1	Taunton,	58	4.7	Holyoke,	72	3.8
Worcester,	176	7.8	Lowell,	117	4.3	Pittsfield,	34	4.9	Springfield,	88	4.3	Haverhill,	49	3.4
Lynn,	118	7.8	Quincy,	21	4.3	Brockton,	41	4.8	Salem,	59	4.0	Marlborough,	24	3.3
Boston,	1,145	7.7	Marlborough,	20	4.3	Quincy,	27	4.8	Newton,	44	4.0	New Bedford,	77	3.2
Somerville,	69	7.6	North Adams,*	16	4.3	Salem,	66	4.7	Boston,	818	3.9	Boston,	722	3.1
Salem,	87	6.9	Lynn,	72	4.1	Northampton,	29	4.6	New Bedford,	71	3.8	Somerville,	65	2.8
Taunton,	65	6.7	Boston,	690	3.9	New Bedford,	62	4.1	Brockton,	46	3.8	Brockton,	41	2.7
Haverhill,	46	6.6	New Bedford,	50	3.8	Marlborough,	20	3.8	Woburn,	24	3.8	Malden,	36	2.7
Marlborough,	27	6.4	Gloucester,	34	3.8	Cambridge,	103	3.7	Cambridge,	116	3.6	Medford,	17	2.7
Gloucester,	51	6.3	Chelsea,	36	3.4	Gloucester,	38	3.7	Malden,	33	3.3	Worcester,	120	2.6
Cambridge,	124	5.7	Medford,	12	3.4	Everett,	9	3.6	Fitchburg,	31	3.3	Cambridge,	91	2.4
Woburn,	26	5.7	Taunton,	34	3.3	Newton,	31	3.4	Everett,	14	3.3	Chelsea,	35	2.4
Malden,	25	5.5	Northampton,	19	3.3	Worcester,	106	3.3	Northampton,	22	3.2	Everett,	18	2.4
Fitchburg,	32	5.4	Beverly,	13	3.3	Somerville,	45	3.3	Worcester,	109	2.8	Lynn,	64	2.2
Beverly,	18	5.2	Newton,	25	3.0	Newburyport,	22	3.2	Somerville,	49	2.8	Taunton,	29	2.2
Quincy,	19	4.6	Somerville,	33	2.8	Chelsea,	37	3.1	Chelsea,	35	2.6	Newton,	28	2.2
Newburyport,	29	4.5	Fitchburg,	17	2.8	Malden,	21	3.0	Newburyport,	17	2.5	Northampton,	17	2.1
Everett,	6	4.1	Brockton,	14	2.3	Waltham,	20	3.0	Lynn,	56	2.2	Beverly,	11	1.9
Medford,	11	3.6	Cambridge,	55	2.2	Fitchburg,	18	2.6	Gloucester,	25	2.2	Fitchburg,	22	1.8
Newton,	20	2.8	Woburn,	10	2.0	Medford,	11	2.6	Medford,	11	2.2	Waltham,	18	1.8
Waltham,	13	2.7	Waltham,	8	1.5	Woburn,	14	2.5	Waltham,	17	2.0	Gloucester,	19	1.4
			Everett,	2	1.0	Beverly,	10	2.3	Beverly,	10	2.0	Pittsfield,	25	1.3
Total,	3,458	-		2,093	-		2,864	-		2,971	-		2,618	-
Means for the cities,	-	8.2		-	4.2		-	5.1		-	4.6		-	3.4
THE STATE,	-	8.2		-	4.5		-	5.0		-	4.1		-	3.2

* North Adams not incorporated till 1878.

Deaths from Typhoid Fever in Massachusetts Cities (1896 and 1897).

	1896.		1897.			1896.		1897.	
	Deaths.	Deaths per 10,000 Living.	Deaths.	Deaths per 10,000 Living.		Deaths.	Deaths per 10,000 Living.	Deaths.	Deaths per 10,000 Living.
Haverhill,	18	5.84	16	5.09	Northampton,	1	0.58	3	1.72
North Adams,	11	5.57	10	4.91	Newton,	7	2.47	5	1.72
New Bedford,	14	2.38	23	3.68	Salem,	4	1.13	6	1.66
Newburyport,	8	5.45	5	3.38	Lawrence,	10	1.86	9	1.62
Boston,	162	3.19	173	3.34	Worcester,	14	1.37	15	1.43
Fall River,	25	2.70	32	3.34	Fitchburg,	4	1.46	4	1.41
Beverly,	4	3.33	4	3.28	Pittsfield,	10	4.72	3	1.37
Lynn,	27	4.23	19	2.91	Cambridge,	30	3.56	11	1.27
Chicopee,	6	3.55	5	2.88	Malden,	6	1.92	4	1.22
Springfield,	11	2.07	15	2.74	Brockton,	6	1.74	4	1.11
Quincy,	9	4.16	6	2.66	Waltham,	4	1.87	2	0.92
Taunton,	6	2.18	6	2.16	Holyoke,	4	0.97	3	0.71
Woburn,	–	–	3	2.08	Marlborough,	3	1.97	1	0.65
Lowell,	36	4.20	18	2.06	Medford,	3	1.98	1	0.63
Somerville,	26	4.73	11	1.90	Gloucester,	9	3.10	1	0.34
Chelsea,	5	1.56	6	1.83	Totals,	489	–	428	–
Everett,	6	2.91	4	1.75	Means,	–	2.90	–	2.47

In the foregoing table the cities are arranged in the order of their typhoid death rates for the year 1897. The cities of Haverhill and North Adams remain at the top of the list in both years.

Diphtheria.

An encouraging feature in the study of the prevalence of infectious diseases in the State is the decline both in the mortality and in the fatality from diphtheria. The deaths and death rates in the three years 1894, 1895 and 1896 from diphtheria and croup, were as follows: —

1. Year.	2. Deaths.	3. Death rates per 10,000 Living.	4. Fatality (Per Cent. of Cases Reported).
1894,	1,801	7.4	27.9
1895,	1,784	7.1	18.9
1896,	1,677	6.6	15.1

The foregoing figures need explanation. It is impossible to state how much of the decrease in columns 2 and 3 is due to improved methods of treatment and how much is due to those unexplained variations in the death rate from infectious disease which appear in every table of this kind which extends over a period of twenty years or more (see Table 46, pages 761–766, report of 1896). It would, however, be difficult to explain, on any other grounds than that of improved treatment and sanitary measures, the very decided changes which appear in column 4. The figures in this column are compiled from the official reports of local boards of health, and do not embrace the whole State. They represent the results which are shown by the reports of about three-quarters of the population. Further information may be found upon this point in Section II. of the Statistical Summaries, page 624, of this report, and in that portion which relates to antitoxin production.

Cerebro-spinal Meningitis.

During the spring of 1897 cerebro-spinal meningitis began to prevail as an epidemic in Boston and its immediate neighborhood, until there had been reported during the year a total of 184 deaths in Boston and many more in the neighboring cities.

Since the nature of the disease is not generally understood, the Board employed experts to investigate and report upon the pathology of the disease. The work was entrusted to Dr. W. T. Councilman, professor of pathological anatomy in the Harvard Medical School, who was assisted by Drs. F. B. Mallory and J. H. Wright. Their report is comprised in a monograph of 178 pages, illustrated with a map showing the distribution of cases in Boston, and with eight colored plates.

The following introductory portion of the report presents a brief statement of the prevalence of the disease in recent years in Massachusetts : —

The prevalence of epidemic cerebro-spinal meningitis in Massachusetts has been marked with much irregularity. An epidemic of unusual severity in 1873 gave rise to an investigation and report by Dr. J. B. Upham, which appeared in the report of the State Board of Health for that year. A summary of 517 cases reported by different physicians throughout the State was given in that report. Dr. Upham was particularly well qualified for this investigation by his previous acquaintance with the disease in Newbern, North Carolina, during the civil war. In considering the causes of the dis-

ease he paid particular attention to the influence of insanitary conditions as an active or predisposing cause. With regard to this he says: —

> The relation of insanitary conditions in and around the abode of the patient to its origin or supposed cause demands the most careful consideration. In weighing the evidence contained in the returns, I find the scale to be pretty evenly balanced in this particular. The cases are distributed among all classes and grades of society, — the high and low, the rich and the poor, locations unexceptionable for situation, open to abundant light and air, and the pent-up hovels of the lowly and wretched, have all contributed to the material of the epidemic. We believe, therefore, that the primal origin of the disease is atmospheric, and, for the present, beyond our ken.

Since Dr. Upham's report, great discoveries in regard to the ætiology of many of the infectious diseases have been made. The bacterium which can now be regarded as the essential cause of epidemic cerebro-spinal meningitis was discovered in 1887, but the first important confirmation of that discovery was not made until 1895. There has always been a great deal of obscurity in the relations between cerebro-spinal meningitis which appeared in an epidemic form and sporadic cases which sometimes appeared alone or in connection with other diseases, and which were very similar in their clinical manifestations and pathological lesions to the epidemic form. With the view of clearing up this and some other obscure points in the general ætiology and pathology of the disease the present investigation has been undertaken by the State Board of Health. The present epidemic is the only one of considerable importance which has been seen since the advance in bacteriology and pathology has made such an investigation possible. In this investigation only the cases which were seen in the principal hospitals and in which the diagnosis of the disease could be regarded as certain have been considered at any length.

The accuracy of the statistics relating to this disease must necessarily be questioned, as presenting a history of its actual prevalence, for the following reason: —

The confusion of medical terms by physicians, together with the fact that all returns made to the State authorities are copies of certificates, and not originals, and that these copies are in the majority of instances made by men who have little or no knowledge of the significance of medical terms, give to the information obtained in regard to this disease a great measure of uncertainty. This is peculiarly true of epidemic cerebro-spinal meningitis, — a disease which is liable to be confounded with several other forms of brain disease in consequence of the similarity in nomenclature of the terms employed to define such diseases. In addition to this, the disease is not a common one, and the clinical manifestations of it are liable to be confounded either with other cerebral diseases or with forms of diseases in which cerebral symptoms predominate.

The whole number of deaths reported in the State as due to cerebro-spinal meningitis during the period of nearly twenty years, ending with Oct. 1, 1897 (nineteen years and nine months), was 2,909, or nearly 150 per year. In this summary the deaths from this cause in the fraction of the year 1897 are those which were reported directly to the State Board of Health by local authorities. The numbers for the years 1878 to 1896, inclusive, were fairly uniform, the maximum being 171 in 1888 and the minimum 78 in 1878. But in the first nine months of 1897 the number reported to the State Board of Health was 405, those in Boston alone being 184.

That these numbers are probably much too large is shown by a classification of the deaths by ages. For this purpose the deaths occurring in the nine years, 1887–95, are selected, since the finer distinction of separating the deaths in each of the first five years of life was first introduced into the State Registration Report in 1887. The deaths recorded in those years by ages were as follows: —

Deaths from Cerebro-spinal Meningitis, Massachusetts, 1887-95.

Age Periods.	Deaths.	Males.	Females.
0–1 year,	316	180	136
1–2 years,	146	74	72
2–3 years,	99	51	48
3–4 years,	77	41	36
4–5 years,	38	19	19
5–10 years,	132	59	73
10–15 years,	81	47	34
15–20 years,	61	36	25
20–60 years,	186	89	97
All over 60 years,	43	12	31
Totals,	1,179	608	571

By the foregoing table it appears that 316 deaths from this disease, or 26+ per cent. of the whole number, were reported as having occurred among children under one year. This fact necessarily vitiates the accuracy of the returns to a considerable degree, since the disease is extremely rare among infants as well as among those of advanced years.

The reported deaths from this cause occurred mainly in the large cities and towns, the whole number reported from towns of less than 5,000 inhabitants being only 136, or less than 5 per cent. of the whole number.

The report deals largely with the pathology of the disease, and contains a brief history of its prevalence in different countries, a description of the character of early epidemics, a digest of 111 clin-

ical cases which were admitted to three hospitals in Boston in 1896 and 1897, a statement relative to the bacteriology of the disease and the diagnostic value of lumbar and spinal puncture, a tabular summary of post-mortem examinations, a statement of the various lesions, and of the other forms of meningitis.

Copies of this special report will be sent to persons who may desire it, upon application to the secretary of the Board, 142 State House, Boston.

Dysentery.

During the past fifty years dysentery has gradually diminished in its destructiveness in Massachusetts until it has ceased to become a prominent factor in the mortality of the State. From a mean mortality of 8.4 per 10,000 living in the five years 1862–66 it had fallen to 0.9 in the five years 1891–95, or less than one-ninth. But in 1896 and 1897 there has been a tendency to a slightly increased mortality from this cause. The prevalence, however, has not been uniformly distributed, but has shown itself in circumscribed localities.

The city of Brockton appears to have suffered the most severely from this disease in 1896, the deaths having been 84, as compared with 5 in each of the two years 1895 and 1897. Further information from Brockton shows that these deaths were not limited to any particular locality but were quite uniformly distributed throughout the city. Of the whole number of deaths from this cause in Brockton 38 were those of children under five years old.

The mortality from this cause in Brockton in 1896 was equivalent to a death rate of 25 per 10,000 of the population, while that of the State from the same cause and in the same year was 1.6 per 10,000, and that of Boston was less than 1 per 10,000.

During the year 1897 other limited epidemics from the same cause occurred in different parts of the State.

The following report of an epidemic of dysentery in South Yarmouth was received in 1897: —

Report of an Investigation of an Epidemic of Dysentery which occurred in South Yarmouth between July 15 and Sept. 30, 1897.

The peculiar diagnostic symptoms which characterized this epidemic as dysentery were the sudden onset, the extreme prostration and bloody discharges. In some instances no premonitory symptoms were manifest until the colicky pains in the bowels and bloody evacuations marked the onset of this disease, while rapid loss of strength, feeble pulse, vesical and rectal

tenesmus attended its progress. Some of the cases recovered in one week, others recovered after periods varying from two weeks to three months; while the fatalities generally occurred within four or five days from the onset of the disease.

The period of incubation or invasion in many of the cases where certainty of exposure could be proven was about one week, as in many of the cases after one member of the family had had the disease about this length of time the remaining members were taken simultaneously.

In several instances no member of a family escaped, while in some families only one or two had the disease.

The prostration and muscular weakness in some cases was so great that the younger members of some families had to learn to walk upon recovering. As a general rule bloody discharges were noticed at the onset of the disease.

In many cases the evacuations were muco-purulent and in some instances shreds and masses of membrane evidently sloughed off portions of the tissues were noted. The fatalities occurred either in quite young or quite old persons.

In the majority of instances this epidemic attacked children between two and twelve years of age. Before giving the details of this epidemic it is quite essential that we should have an understanding of the topography, conditions of soil, water supply, conditions and habits of life of this village.

South Yarmouth is situated along the west bank of Bass River. The land is low and level, at no point being more than twenty-five feet above the surface of this sluggish stream, or, more properly, an inlet of the ocean. The soil is light and sandy, and at a depth of fifteen or twenty feet there is a clay stratum which is quite impervious.

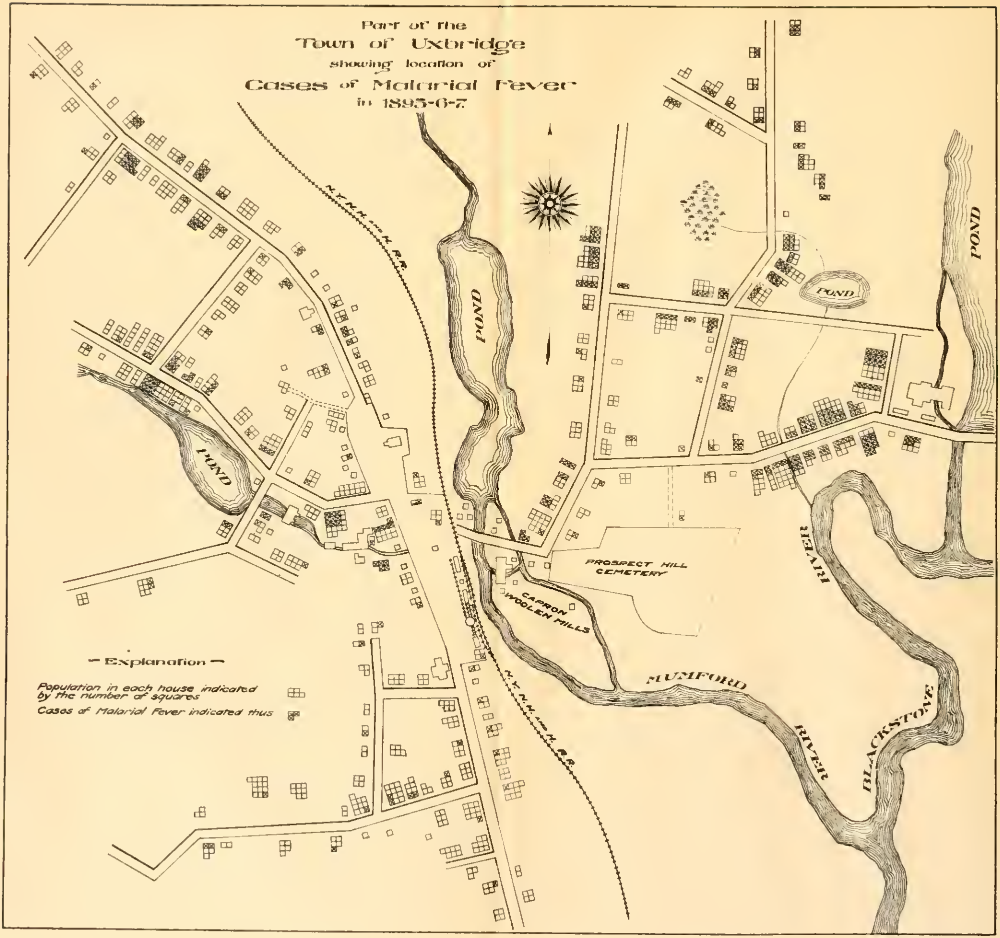
The water supply in every instance where this epidemic occurred is obtained from driven wells, which, as near as could be ascertained, were about fifteen or twenty feet deep.

There is no system of sewage, the drainage pipe from the sink opening at the surface of the ground into a trench about eighteen inches wide and often filled with stagnant dish-water and matters from vegetable decomposition.

In one instance, where this epidemic started, this trench was found to be only twelve feet from the well pipe. In another case, where a fatality occurred, the privy was fifteen feet from a driven well. In many instances the dish-water is simply thrown upon the surface of the ground to be absorbed and often only ten or fifteen feet away from a driven well.

There was no one milk supply, as various cows kept by neighbors supplied milk to the families who had this disease.

Careful inquiry elicited the fact that no member of the family where the disease started had been away from home for at least one month, and no one had visited this home during this period, so that the conditions which



HELIOTYPE PRINTING CO. BOSTON

produced the epidemic must be sought for in the home and the immediate surroundings.

Socially the village may be divided into two parts, north village or as it is called "Georgetown," and the village proper.

The epidemic started July 15 in north village, which is situated about one-half mile north of South Yarmouth proper, and consists of fourteen small one-story wooden houses situated quite closely together. The inhabitants are all of the poorer class and have not much regard for the sanitary condition of their surroundings.

Malarial Fever.

During the past year, so far as can be learned from the reports of local health authorities, malarial fever has not prevailed quite as extensively as in the previous year. The cities and towns attacked have been the same as in the years immediately preceding, with the exception of a limited prevalence in the towns lying about the easterly end of the new metropolitan reservoir and of basin No. 5 in Southborough.

Brief mention has been made in the last two reports of the appearance of malarial fever at Uxbridge, in the valley of the Blackstone River. The disease has prevailed in that town quite extensively in each of the past three years, 1895, 1896 and 1897. There are in the town several mill-ponds interspersed among three villages, in each of which there is a considerable manufacturing population. The elevation of most of the houses throughout the densely settled portion of the town varies from eight or ten feet to forty feet or more above the mill-ponds.

The accompanying map has been prepared to show the location of the inhabited houses in the town, with the number of persons in each house, and the number who have been attacked with malarial fever at some time during the years 1895, 1896 and 1897. The whole number of small squares in each instance represents the number of persons living in the house, and the shaded squares show the number in each house who were attacked with malarial fever during one or more of these three years.

This map presents only the densely settled part of the town. Other cases also occurred in outlying districts, especially in one manufacturing village a short distance easterly from the portion shown on the map.

One condition appears to be common to all the districts which have been invaded with malaria in Massachusetts, namely, the pres-

ence of moist lands in an unusual degree. The mill-ponds and meadows upon the Housatonic, the Connecticut, the lower portion of the Deerfield, the Blackstone at Uxbridge, the Sudbury at Framingham, the Charles at Newton and the other towns along its shores, the low lands along the sources of the Mystic in Woburn and Winchester, the tributaries of the Saugus at North Saugus and the mill-pond at Pranker's dam in Saugus, have furnished the districts in which malaria has chiefly appeared.

Offensive Trades.

During the past year no instances requiring the action of the Board have been referred to it under the provisions of the offensive trade acts. The advice of the Board has been sought in a few instances with reference to the proper treatment of such cases, and the places have been inspected by the Board, but the necessary action has in each instance been taken by the local board of health.

Inspection of Summer Resorts.

The importance of some supervision over the summer resorts, picnic and camp grounds throughout the State becomes more evident every year. Occasionally epidemics of disease are traced to these places among persons who have visited them and then returned to their homes, such illness having undoubtedly been due to the unsanitary condition of these places.

In most instances these resorts are located upon the shores of some pond or stream, and not unfrequently the water supply selected for the use of the patrons of these places is taken from the same pond or stream. When the source is one of undoubted purity, the water may be used with impunity, but it too often happens that the drainage of these places finds its way into the pond or stream, and renders it unfit for drinking purposes.

There should be, therefore, some legal provision by which no resort shall in future be established upon the shores or watershed of any stream or pond used or likely to be used as a water supply, without definite supervision or requirement with reference to its water supply and drainage such as is provided by chapter 375 of the Acts of 1888, section 3. Such a provision would undoubtedly prove to be a double protection, since it would not only afford better security to the patrons of these places, but also would prevent the pollution,

by the drainage of such places, of the water supplies of cities and towns.

The secretary was instructed by the Board to "notify the owners of these resorts of such unsanitary conditions as were found to exist, and that they should be requested to devise plans for improving such conditions."

Letters were therefore addressed to the owners or superintendents of these places, and especially to those who had been notified in the preceding year, but had not complied with the suggestions of the Board.

The Bacteriological Work of the Board.

The concise phrase so often met with at the present day in the reports of the transactions of many continental health authorities, namely, "the campaign against infectious diseases," expresses better than any other the most important work of any board of health whether local, State or national.

Infectious diseases are everywhere present and contribute very largely, not only to the rolls of mortality, but also to the hospitals and infirmaries intended to receive their victims. That man, by energetic means, by the employment of modern methods both for the prevention and the treatment of this class of diseases, has been enabled to limit not only their relative effect upon the population but also their fatality,* is a matter susceptible of definite proof.

One of the most important weapons for use in this campaign is the bacteriological department, which now forms a part of the equipment of most public sanitary organizations. The bacteriological laboratory of the Board, established at the Bussey Institute, near the Forest Hills station, on the New York, New Haven & Hartford Railroad in 1894, has proved a very efficient aid to the work of the Board.

The special lines of work carried on at the laboratory during the past year have been the examination of diphtheria cultures, of material suspected to contain the bacilli of tuberculosis, the blood of malarial patients, the production of diphtheria and of tetanus antitoxin, and of such other work relative to the investigation of infectious diseases as was referred to this department.

The question of conducting a work of this character, which in-

---

* The term "fatality" is here used to denote the ratio of deaths from any given cause to the number of cases.

volved the giving of aid to local boards of health at considerable distances from the laboratory, has passed beyond the experimental stage. It at first appeared somewhat doubtful whether the cultures of diphtheria bacilli could be successfully carried out for boards of health in western Massachusetts, but during the past year, out of a total of 2,204 cultures, 556 were received for examination from the boards of health of cities and towns more than fifty miles distant from the laboratory, and 125 of these were from places one hundred and fifty miles and over from the laboratory. All of these are sent by express or messenger, as in the case of samples of material from tuberculous patients or persons suspected of being tuberculous. In a few instances packages have been forwarded by mail, through ignorance of the law. This can be done only when packages are used which are approved by the postal authorities. Since the express delivery is quite as prompt as the mail, the Board requires that all packages shall be sent by express, or messenger, as a condition for their examination, except those which contain the dried specimens of blood, which cannot be regarded as infectious material.

Local Nuisances.

A popular impression has existed since the first establishment of the State Board of Health that one of the functions of the Board is the suppression of local nuisances in cases where the local board either neglects or refuses to act, and that the State Board was constituted a board of appeal in such instances. No such power, however, was ever given by the statutes to the State Board. The only board of appeal in such instances is the board of county commissioners, which can act under the following statute (P. S., chapter 80, section 36) : —

"Any person aggrieved by the neglect or refusal of the board of of health in a city or town to pass all proper orders abating a nuisance or nuisances may appeal to the county commissioners, who may hear and determine the matter of such appeal, and exercise in such case all the powers which the board might exercise."

A local board of health is required by law "to examine into all nuisances, sources of filth and causes of sickness within its town, or in any vessel within the harbor of such town, that may in its opinion be injurious to the health of the inhabitants, and destroy, remove or prevent the same as the case may require."

Under the provisions of this law the authority of local boards is very great. In the words of Judge Wells, in the case of the city of Salem against the Eastern Railroad Company, "Their action is intended to be prompt and summary. They are clothed with extraordinary powers for the protection of the community from noxious influences affecting life and health; and it is important that their proceedings should be delayed as little as possible. Delay might defeat all beneficial results; and the necessity of the case and the importance of the public interests at stake justify prompt action."

The utmost that the State Board can do in all such instances is to advise, but not to act in an executive capacity.

Food and Drug Inspection.

The work of the Board in the department of food and drug inspection is conducted under the provisions of an act which was passed in 1882, and amended in the following year, by which an annual appropriation (at present amounting to $11,500) is made for carrying out the provisions of the act.

The work of the first year was mainly in the direction of investigation, for the purpose of ascertaining the actual existing condition with reference to the matter of adulteration of food and drugs. Certain conditions were found to exist which aided in establishing a basis for future work. It was found that popular notions in regard to the extent and the character of food adulteration were considerably exaggerated; that food adulteration was mainly confined to certain articles, the most valuable of which was milk; that certain staple articles of food, such as the cereals and sugars, were very rarely adulterated; that careful inspection and supervision of the food supply resulted in a decided diminution in the ratio of adulteration, especially in the case of milk and spices; and that cases of adulteration of articles of food with substances actively harmful or injurious to the health of the consumer were far more rare than adulterations of a fraudulent or commercial character only.

The whole number of samples examined since the beginning of work under this act was 86,793, and of this number 28,647, or 33 per cent., were found to be below the required standard of purity. Sufficient comment has heretofore been made upon the fact that these examinations do not represent the actual condition of the food market in this State, since experience in the work of collection has taught the inspectors to select for examination mainly those articles

which are liable to adulteration. By this means the percentage of adulteration published annually in the report of the Board and monthly in its bulletins far exceeds the actual percentage, when all articles of food are taken into account.

It is quite certain that the protection afforded by the constant supervision exercised under the provisions of the food and drug acts, when considered from an economic stand-point, far exceeds the sum appropriated annually for the enforcement of the law.

Drugs.

Food differs from medicine, both in importance to the human race and in the quality and character of the adulterations to which it is subjected. The Board has endeavored to apportion the work performed in its department of food and drug inspection in accordance with the relative importance of these two subjects, and hence the time spent in the analysis of drugs, and the number of samples examined has usually been about ten to fifteen per cent. of the whole time occupied, and of the samples examined.

In the report of a committee of experts in 1880, which formed the basis of the State laws of Massachusetts and other States upon food inspection, it was shown that legislation was needed more for commercial than for sanitary reasons. So far as food is concerned this statement is correct. In the matter of drugs, and especially of patent medicines, however, legislation does not appear to have made so rapid progress as in the direction of food inspection.

It was shown in a recent report that one single article of food — butter — was protected in Massachusetts by the existence of four sets of officials, so that violation of the law in regard to this article had become almost impossible in the State.

On the other hand, the laws relating to the sale of proprietary medicines, recently enacted, appear to have been framed, so far as these articles are concerned, in the interest of the manufacturer rather than in that of the consumer.

By the statute of 1888, chapter 209, a law was enacted which afforded some protection against the careless and illegal sale of poisons. This act was framed upon conditions somewhat similar to those which prevail in England, and specified a considerable number of poisons, but by the law of 1896, an exception was made in favor of the unlimited sale of proprietary medicines. It was shown, not only in the early reports of this Board but also in the summary

presented in the last report that very many proprietary medicines contained violent, irritating poisons, that others were calculated to deceive consumers and lead to the formation of incurable habits, in consequence of the ignorance of the consumer as to their actual contents. Instances have repeatedly come to the knowledge of the Board of serious injury in consequence of this defect in the law, and it is desirable that the defect should be remedied.

Library and Publications of the State Board of Health.

During the twenty-nine years since the establishment of the State Board of Health an excellent library of works upon public hygiene has been collected at the office of the Board, consisting of about four thousand volumes of books and a large collection of pamphlets, which have been obtained either by gift, purchase or exchange. The principal topics embraced in the collection are the following: —

General hygiene, including many treatises on public health and State medicine.

Water supply, sewerage and sewage disposal. This collection contains a very full list of the reports of city and town water boards and sewerage commissions, not only of Massachusetts municipalities, but also those of other cities, both American and foreign, together with many maps, plans and charts illustrating the work of the engineering department of the Board.

Food and drug inspection.

Infectious diseases, especially cholera, typhoid fever, small-pox and vaccination, including the very full reports of the recent parliamentary commission of England upon vaccination.

School hygiene.

Hospitals, general and special.

Animal diseases.

Bacteriology.

Disposal of the dead.

Medical jurisprudence and toxicology.

United States government reports.

Reports of State boards of health of United States (full sets).

Reports of city boards of health.

Reports of the health authorities of foreign governments.

Vital statistics. This collection comprises nearly full sets of the registration reports of each of the New England States and of Michigan, Minnesota and Ontario; a full set of the registrar-general's reports of England; also partial sets of Austrian, Russian, Swiss, Italian, Scotch, Irish and Japanese reports.

The following periodicals are received regularly at the office of the Board, either by exchange or otherwise : —

Transactions of American Public Health Association, full set.
The Boston Medical and Surgical Journal, Boston (weekly).
The Journal of the American Medical Association of Chicago (weekly).
The Sanitary Record, London (weekly).
Public Health, London (monthly).
Bulletins of State and city boards of health.
Reports of the Local Government Board of England, annual and supplements.
The Local Government Chronicle, London (weekly).
Food and Sanitation, London (weekly).
The Journal of the Sanitary Institute, London (quarterly).
The Journal of the Society of Arts, London (weekly).
The Journal of the Franklin Institute, Philadelphia (monthly).
The Engineering Record, New York (weekly).
The Surveyor, London (weekly).
The Analyst, London (monthly).
The Druggists' Circular, New York (monthly).
Journal of the Royal Statistical Society, London (yearly).
Statistisches Jahrbuch, Berlin (yearly).
Deutsche Rundschau, Berlin (bi-weekly).
Annales de l'Institut Pasteur, Paris (monthly).
Revue d'Hygiene, Paris (monthly).
Zeitschrift für Hygiene und Infections Krankheiten, Leipzig (bi-monthly).
Journal d'Hygiene, Paris (weekly).
Veröffentlichungen, Kaiserliches Gesundheitsamt.
Arbeiten, Kaiserliches Gesundheitsamt.
Vierteljahrsschrift für öffentliche Gesundheitspflege (quarterly).
Centralblatt für allgemeine Gesundheitspflege (monthly).
Massachusetts Medico Legal Society Transactions (yearly).
Revue internationale des falsifications, Amsterdam (monthly).
The Ephemeris, irregularly, Brooklyn, New York.
The Index Medicus (monthly).
Bulletin. D'Institut International Statistique, Rome (yearly).
United States Department of Agriculture.
Reports of Bureau of Animal Industry.
Bulletins of Division of Chemistry.
Bulletins of New England Weather Service.
United States Marine Hospital Service. Weekly Abstract of Sanitary Reports.
Transactions of Massachusetts Medical Society (yearly).
Journal of Massachusetts Association of Boards of Health (quarterly).

This library is not for general circulation, but these volumes and pamphlets may be consulted at the office on any day from 9 to 5 by persons who are interested in the subject of hygiene.

The regular publications of the Board are its annual reports, required by the provisions of chapter 101 of the Acts of 1886, section 2; an annual report upon the prosecutions and expenditures made under the food and drug acts, chapter 289, Acts of 1884, section 2; an annual report upon its doings in relation to the care and oversight of inland waters, under chapter 375 of the Acts of 1888, section 1 (usually numbered as Senate, Doc. 4).

In addition to the foregoing annual reports, the Board issues a weekly bulletin, containing the following items: a weekly statement of the number of cases of diseases dangerous to the public health reported to the State Board of Health by local boards of health under the provisions of chapter 302 of the Acts of 1893, section 1; a weekly statement of the deaths in each city and town (this is a voluntary report and does not comprise the smaller towns); a monthly statement of the operations of the department of food and drug inspection.

The Board has also published from time to time special reports in compliance with resolves of the Legislature, upon various subjects: the sale and use of opium; the manufacture of oleomargarine; on the existence of arsenic in wall paper and other fabrics; the pollution of ice supplies; the manufacture of artificial ice; the system of sewerage for the north metropolitan district; the metropolitan water supply; the improvement of the Charles River, the Neponset River and of the Concord and Sudbury rivers; the restoration of Green Harbor; the sewerage of Salem and Peabody.

It has also published, under its general authority to "gather information upon health matters for diffusion among the people" (chapter 104, Acts of 1886, section 4), many circulars on the prevention of infectious diseases, disinfection, the use of antitoxin, etc., including the valuable monograph upon Cerebro-spinal Meningitis by Dr. Councilman, published during the present year, and a reprint of Dr. Russell's paper on the Prevention of Tuberculosis.

Copies of these two reports can be had on application to the Board.

Local Boards of Health.

It has been customary to place in the annual report of the State Board a digest of such matters of special interest as appear in the annual reports of local boards of health to their respective municipal authorities under the title of Health of Towns. An examination of the material presented in the present year shows in the reports of these boards a very marked progress in sanitary matters in many directions.

In six of the larger cities of the State special mention is made of the urgent need of isolation hospitals. During the past year the city of Worcester has completed an excellent contagious disease hospital in a well-selected location, which is now doing good service in caring for persons sick with infectious diseases. There are now at least eight cities and towns furnished with these useful institutions.

Another important matter which appears in these reports is the supervision of the production and sale of milk by the local boards, including the inspection of the dairies and the animals where the milk is produced. The recent discussion of this question at the meetings of the Massachusetts Association of Boards of Health has evidently borne good fruit.

The law in regard to the supervision of bakeries recently enacted has been recognized by the local boards, and inspections and improvements have been made in these establishments in most of the cities.

Formaldehyde has been quite generally introduced as a gaseous disinfectant for apartments by local boards in place of sulphur dioxide, and in one city (Newton) experiments have been conducted to determine its efficiency and are reported in the annual report of the local board of that city.

In all the cities antitoxin has been used, furnished by the State Board, and favorable results are generally reported from its use.

In most of the large cities bacteriological laboratories have been established as auxiliaries to the work of the local boards in determining the character of such infectious diseases as it is possible to decide upon by this means. The State Board conducts a similar line of work for many other cities and towns which are not thus provided.

In Boston, Cambridge and Newton a systematic medical inspection of schools is conducted, following the plan inaugurated by the Boston board of health.

In one city (North Adams) action has been taken by the local board of health, under the provisions of chapter 338 of the Acts of 1895, with reference to the sale of ice from polluted sources of supply.

Special attention is called in several reports to the need of improved means of garbage disposal in some of the larger cities. Thus far Lowell is the only city in the State which has maintained continuously for several years an establishment for the destruction of garbage by fire. A brief extract from the report of the local board of health upon this subject may be found in the section of this report upon the Health of Towns.

Several reports mention the subject of limiting the keeping of swine in populous districts, and local boards have provided regulations to prevent nuisance from this cause.

In several of the larger cities facilities for bathing have been offered to the inhabitants, by means either of open-air establishments or, as in Boston and Brookline, by bath-houses for use both in summer and winter. The new public bath-house at Brookline is a model in its equipment, and furnishes not only the means for bathing for both sexes, but facilities for instruction in the healthful and life-saving art of swimming.

At the summer bathing establishments in Boston, 18 in number, in 1897, the whole number of baths recorded during the season was 657,275.

The Registration of Vital Statistics.

In the last report of the Board a very full summary of the vital statistics of the State was presented, embracing a period of forty years (1856–95). Hence the following summary relates chiefly to the additional figures for 1896.

Assuming that the rate of growth from 1890 to 1895 has been continued to 1896, the population for 1896 is estimated to have been 2,555,987. The following table presents in a condensed form the vital statistics of the State for the fifty years 1847–96 : —

A Half Century of Registration.

Marriages, Births and Deaths in MASSACHUSETTS (1847-1896), with Population and Rates per 1,000 Living.

Years.	Population.	Marriages.	Births.	Deaths.	Excess of Births over Deaths.	Persons Married to 1,000.	Births to 1,000 Persons.	Deaths to 1,000 Persons.	Excess Rate.
1846-47,*	909,267	5,390	17,097	14,492	–	–	–	–	–
1847-48,*	936,838	5,287	16,515	15,609	–	–	–	17.17	–
1848,†	–	4,015	12,540	12,475	–	–	–	19.58	–
1849,‡	965,245	6,936	25,773	20,423	5,350	–	26.70	21.16	5.54
1850, ...	**994,514**	10,345	27,664	16,606	11,058	20.80	27.82	16.70	11.12
1851, ...	1,020,673	11,966	28,681	18,934	9,747	23.44	28.10	18.55	9.55
1852, ...	1,047,520	11,578	29,802	18,482	11,320	22.10	28.45	17.64	10.81
1853, ...	1,075,072	12,828	30,920	20,301	10,619	23.86	28.76	18.88	9.88
1854, ...	1,103,350	13,683	31,997	21,414	10,583	24.80	29.00	19.41	9.59
1855, ...	**1,132,369**	12,329	32,845	20,798	12,047	21.77	29.01	18.37	10.64
1856, ...	1,151,461	12,265	34,445	20,734	13,711	21.30	29.91	18.00	11.91
1857, ...	1,170,864	11,739	35,320	21,280	14,040	20.05	30.16	18.17	11.99
1858, ...	1,190,584	10,527	34,491	20,776	13,715	17.68	28.97	17.45	11.52
1859, ...	1,210,657	11,475	35,422	20,976	14,446	18.96	29.26	17.33	11.93
1860, ...	**1,231,066**	12,404	36,051	23,068	12,983	20.15	29.28	18.74	10.54
1861, ...	1,238,177	10,972	35,445	24,085	11,360	17.72	28.63	19.45	9.17
1862, ...	1,245,328	11,014	32,275	22,974	9,301	17.69	25.92	18.45	7.47
1863, ...	1,252,521	10,873	30,314	27,751	2,563	17.36	24.20	22.15	2.05
1864, ...	1,259,756	12,513	30,449	28,753	1,696	19.87	24.17	22.83	1.35
1865, ...	**1,267,031**	13,051	30,249	26,152	4,097	20.60	23.87	20.64	3.23
1866, ...	1,302,992	14,428	34,085	23,637	10,448	22.14	26.16	18.14	8.02
1867, ...	1,339,976	14,451	35,062	22,772	12,290	21.57	26.17	17.00	9.17
1868, ...	1,378,010	13,856	36,193	25,603	10,590	20.12	26.26	18.58	7.68
1869, ...	1,417,125	14,826	36,141	26,054	10,087	20.92	25.50	18.39	7.12
1870, ...	**1,457,351**	14,721	38,259	27,329	10,930	20.20	26.25	18.75	7.50
1871, ...	1,494,334	15,746	39,791	27,943	11,848	21.08	26.63	18.70	7.93
1872, ...	1,532,258	16,142	43,235	35,019	8,216	21.08	28.22	22.85	5.37
1873, ...	1,571,146	16,437	44,481	33,912	10,569	20.92	28.31	21.58	6.73
1874, ...	1,611,022	15,564	45,631	31,887	13,744	19.32	28.32	19.79	8.53
1875, ...	**1,651,912**	13,663	43,996	34,978	9,018	16.54	26.63	21.17	5.46
1876, ...	1,677,351	12,749	42,149	33,186	8,963	15.20	25.13	19.78	5.34
1877, ...	1,703,182	12,758	41,850	31,342	10,508	14.98	24.57	18.40	6.17
1878, ...	1,729,410	12,893	41,238	31,303	9,935	14.91	23.84	18.10	5.74
1879, ...	1,756,042	13,802	40,295	31,801	8,494	15.72	22.94	18.11	4.83
1880, ...	**1,783,085**	15,538	44,217	35,292	8,925	17.42	24.80	19.79	5.01
1881, ...	1,813,818	16,768	45,220	36,458	8,762	18.49	24.93	20.10	4.83
1882, ...	1,845,081	17,684	45,670	36,785	8,885	19.17	24.75	19.93	4.82
1883, ...	1,876,883	18,194	47,285	37,748	9,537	19.38	25.19	20.11	5.08
1884, ...	1,909,233	17,333	48,615	36,990	11,625	18.16	25.46	19.38	6.08
1885, ...	**1,942,141**	17,052	48,790	38,094	10,696	17.56	25.12	19.61	5.51
1886, ...	1,998,174	18,018	50,788	37,244	13,544	18.04	25.41	18.64	6.77
1887, ...	2,055,823	19,533	53,174	40,763	12,411	19.00	25.87	19.85	6.04
1888, ...	2,115,136	19,739	54,893	42,097	12,796	18.66	25.95	19.90	6.05
1889, ...	2,176,159	20,397	57,075	41,777	15,298	18.74	26.23	19.20	7.03
1890, ...	**2,238,943**	20,838	57,777	43,528	14,249	18.62	25.81	19.44	6.37
1891, ...	2,288,911	21,675	63,004	45,185	17,819	18.94	27.53	19.74	7.79
1892, ...	2,339,993	22,507	65,824	48,762	17,062	19.24	28.13	20.84	7.29
1893, ...	2,392,216	22,814	67,192	49,084	18,108	19.07	28.09	20.52	7.57
1894, ...	2,445,604	20,619	66,936	46,791	20,145	16.86	27.37	19.14	8.24
1895, ...	**2,500,183**	23,102	67,545	47,540	20,005	18.48	27.02	19.01	8.01
1896, ...	2,555,987	23,651	72,343	49,381	22,962	18.51	28.30	19.32	8.98

* The statistics of the first two years of registration given in the foregoing table are for the years ending with April 30 of each year.

† The second line of statistics for 1848 is for the eight months ending Dec. 31, 1848.

‡ The statistics for 1849 and for each of the following years are for the calendar years ending December 31.

All estimates of inter-censal years are made by the geometric rate of increase.

The vital statistics of the first seven years of registration (1842-1848), together with the returns of marriages for 1849, must be regarded as extremely defective; many of the returns from Suffolk County for this period are wanting, together with those of some of the small towns. From the year 1849 onward the omissions probably constitute but a small percentage only of the total registration.

The figures for the population of Census years are given in bold type.

Marriages.

The marriages registered in 1896 were 23,651, a number greater than those of any previous year. The marriage rate upon the foregoing estimate was 18.5 per 1,000 of the living population, which was slightly higher than that of 1895.

Nativity. — Of the whole number of persons married whose nativity was known 55.2 per cent. were of native and 44.8 per cent. were of foreign birth. Estimating the increase in the sexes at the same rate as that of the previous five years, the marriage-rates of the two groups were very nearly the same as those of 1895, those of the natives being 14.84 per 1,000 and that of persons of foreign birth 26.84 per 1,000. The difference being partly accounted for by differences in the age constitution of the two groups (see twenty-eighth annual report, page 728).

Season. — The following table presents the number of marriages in each month of the year, the daily number in each month and the centesimal ratio in each month (or, in other words, the number which would have occurred in each month upon a basis of 100 as a daily mean throughout the year). From a comparison with table 17 on page 730, twenty-eighth annual report, it appears that the month of June has grown in popular favor as a month for marrying, the figures having been as follows: for the twenty years 1856–75, the centesimal ratio for June was 104.1; for the next twenty years, 1876–95, it was 126.2; for the single year 1895 it was 151.5 and for 1896, 161.3, as compared with a daily mean of 100 for the year. On the other hand the month of November has diminished in favor from a centesimal ratio of 151.6 in the first twenty years to 147.8 in the second twenty years and 144.7 in 1895 and 137 in 1896.

Marriages, by Months, 1896.

Months.	Marriages.	Daily Mean.	Centesimal Ratio.	Months.	Marriages.	Daily Mean.	Centesimal Ratio.
January,	1,830	59.3	91.4	August,	1,686	54.4	84.2
February,	1,693	58.4	90.4	September,	2,206	73.5	113.7
March,	911	29.4	45.5	October,	2,510	81.0	125.4
April,	2,271	75.7	117.1	November,	2,654	88.5	137.0
May,	1,459	47.1	72.8	December,	1,636	52.8	81.7
June,	3,126	104.2	161.3	Total,	23,651	-	-
July,	1,669	53.8	83.3	Daily mean for whole year,	-	64.6	100.0

Births.

The births registered in 1896 were 72,343, or 4,798 more than those of the preceding year. The birth-rate, upon an estimate of 2,555,989 inhabitants, was 28.3 per 1,000. This was a higher rate than that of any preceding year since 1874.

Sex. — Of the whole number of living infants born in 1896 the sex of which was known 37,186 were males and 35,114 were females, which was in the ratio of 1,056 males to 1,000 females. That of the forty-year period 1856–95 was very nearly the same (1,055 males per 1,000 females). If the still-births are included these figures are a little higher in each instance (1,073 for the single year 1896 and 1,066 for the forty-year period 1856–95).

The following table presents the ratio of males to females of living and of still-births for the years 1895 and 1896 and for the ten-year period 1887–96 : —

Births, Ratio of Males to Females.

		1895.	1896.	Ten Years. 1887-96.
Born alive,	Males,	34,623	37,186	320,704
	Females,	32,905	35,114	304,718
	Not stated,	17	43	338
Males to 1,000 females,		1,052	1,056	1,052
Still-born,	Males,	1,423	1,558	13,010
	Females,	892	983	8,399
	Not stated,	52	74	742
Males to 1,000 females,		1,595	1,585	1,549

Nativity. — Of the whole number of living births, 22,810 were of native, 34,237 of foreign, and 15,033 were of mixed parentage. Estimating the growth of each group of the population in the same manner as that of the whole population, and distributing the children of mixed birth proportionally between the two groups, the birth-rates were 17.2 for the native and 53.1 for the foreign population. These very great differences are explained in the last annual report, page 737.

Seasons. — The following table presents the seasonal distribution of the births for the year 1896 : —

Births, by Months, 1896.

Months.	Births.	Daily Mean.	Centesimal Ratio.	Months.	Births.	Daily Mean.	Centesimal Ratio.
January,	5,852	188.8	95.5	August,	6,551	211.3	106.9
February,	5,543	191.2	96.8	September,	6,206	206.9	104.7
March,	6,016	194.0	98.2	October,	6,123	197.5	99.9
April,	5,902	196.7	99.5	November,	5,943	198.1	100.3
May,	5,952	192.0	97.2	December,	6,176	199.2	100.8
June,	5,840	194.7	98.5				
July,	6,229	200.9	101.7	Totals,	72,333	197.6	100.0

Still-births. — The registered still-births in 1896 numbered 2,615, of which number 1,558 were males, 983 were females and the sex of 74 was unknown. The statistics of still-births for the past forty years show that their ratio to the total number of births living and still-born has been gradually increasing. Their percentage of the total number of births for the twenty years 1856–75 was 2.54, for the next twenty years, 1876–95, it was 3.26, for the ten years 1887–96 it was 3.42 and for 1896 it was 3.49. This may possibly be due to more accurate registration.

The ratio of males to females among the still-born remains fairly constant. For the year 1896 it was in the proportion of 1,585 males to 1,000 females. The sex of 74 being unknown. For the twenty years 1856–75, it was as 1,501 males to 1,000 females and for the twenty years 1876–95 it was as 1,489 males to 1,000 females. (See also table on page xxxii.)

Plural births. — The number of registered cases of plural births in 1896 was 729, of which 719 were cases of twins and 10 were cases of triplets. Of the whole number, 51.4 per cent. were males, and 48.6 per cent. were females.

The ratio of plural births to single births (living) is expressed in the following table: —

Plural births, 1856-95 and 1896.

Periods.	All Births.	Cases of Twins.	Cases of Triplets.	Percentage of Twin Births.	Percentage of Triplet Births.	Living Births to One Case of Twins.	Living Births to One Case of Triplets.
1856-75,	731,335	6,852	76	0.94	.013	106.7	9,623
1876-95,	1,049,537	9,450	109	0.90	.013	111.1	9,629
1896,	72,343	719	10	0.99	.014	101.0	7,234

Deaths.

The number of deaths registered in 1896 was 49,381, a greater number than that of any previous year. The death-rate as calculated from the estimated population was 19.32 per 1,000, as compared with 19.01 in 1895, 19.13 in 1894 and 19.51 in the twenty-year period 1876–95.

Sexes. — The deaths of males were 25,140 and those of females were 24,241. Estimating the rate of growth of the male and female populations, upon the basis of the increase from 1890 to 1895, the death-rate of males was 20.2 per 1,000 and that of females 18.4.

Months. — By the following table it appears that the months in which the highest mortality prevailed in 1896 were July, August and September, as in most of the preceding years of registration, together with March and April. The months having the lowest mortality were November, October and June.

Mortality by Months, Massachusetts, 1896.

Months.	1 Males.	2 Females.	3 Totals.	4 Death-rate per 1,000.	5 Centesimal Ratio.	6 Deaths per Day.
January,	1,880	1,945	3,825	18.1	91.5	123.4
February,	1,893	1,863	3,756	17.7	96.0	129.5
March,	2,085	2,117	4,202	19.8	100.5	135.5
April,	2,130	1,992	4,122	19.3	101.9	137.4
May,	2,064	1,976	4,040	19.0	96.6	130.3
June,	1,875	1,747	3,622	17.0	89.5	120.7
July,	2,757	2,666	5,423	25.3	129.6	174.9
August,	2,828	2,563	5,391	25.2	128.8	173.8
September,	2,061	2,038	4,099	19.1	101.3	136.6
October,	1,889	1,849	3,738	17.4	89.4	120.6
November,	1,714	1,637	3,351	15.6	82.8	111.7
December,	1,964	1,848	3,812	17.7	91.5	123.0
	25,140	24,241	49,381	19.3	100.0	134.9

Deaths by Ages. — The deaths by ages were as follows: —

		Per Cent. at Each Period of Life.
Under one year,	11,765	23.9
Under five years,	16,621	33.7
Five to twenty years,	3,156	6.4
Twenty to sixty years,	16,063	32.6
All over sixty years,	13,460	27.3
Age unknown,	81	–
Total,	49,381	100.0

It appears that 33.7 per cent. of the deaths, or fully one-third, were those of children under five years, and 23.9 per cent., or nearly one-fourth, were those of infants under one.

The following table presents the infant mortality of the cities of Massachusetts for the year 1896 and for the ten years 1881–90, the term "infant mortality" as employed in this table meaning the ratio of deaths under one year in 1,000 living births: —

Infant Mortality of Cities, Ten Years, 1881-90 and 1896.

Cities.	Births, 1896.*	Deaths under One, 1896.	Infant Mortality. 1896.	Infant Mortality. 1881-90.	Centesimal Rank. 1896.	Centesimal Rank. 1881-90.
Fall River,	3,374	806	238.9	239.7	147	149
Lowell,	2,764	584	211.3	222.5	130	139
Lawrence,	1,780	315	176.9	213.9	109	133
Boston,	16,477	2,670	162.0	188.2	99	117
Salem,	1,042	193	185.2	180.6	114	112
New Bedford,	2,127	466	219.1	177.7	135	111
Chicopee,	644	145	225.1	176.1	138	110
Cambridge,	2,539	403	158.7	172.3	98	107
Holyoke,	1,678	267	159.1	168.1	98	105
Chelsea,	1,023	132	129.0	166.9	79	104
Springfield,	1,502	234	155.8	157.3	96	98
Haverhill,	879	142	161.5	157.1	99	98
Worcester,	3,180	407	128.0	155.6	79	97
Marlborough,	380	64	168.4	154.6	104	96
Somerville,	1,540	206	133.8	154.3	82	96
Newburyport,	329	43	130.7	152.7	80	95
Brockton,	888	128	144.1	146.9	89	91
Pittsfield,	529	70	132.3	144.8	81	90
Lynn,	1,680	279	166.1	140.7	102	88
Taunton,	765	141	184.3	140.5	113	87
Gloucester,	669	95	142.0	138.8	87	86
Northampton,	411	65	158.1	135.7	97	84
Fitchburg,	916	143	156.1	134.3	96	84
Malden,	864	107	123.8	133.4	76	83
Everett,	691	100	144.7	131.9	89	82
Waltham,	489	73	149.2	131.7	92	82
Medford,	413	62	150.1	130.9	92	81
Woburn,	445	80	179.8	127.0	111	79
Quincy,	713	91	127.6	124.0	78	77
Beverly,	280	22	78.6	118.9	48	74
North Adams,	671	105	156.5	115.1	96	72
Newton,	779	101	129.7	111.9	80	70
Urban,	52,461	8,739	166.2	174.9	102	109
Rural,	19,882	3,026	152.2	129.5	94	80
The State,	72,343	11,765	162.6	160.4	100	100

* The figures employed in this column are those of the calendar year 1896.

By the foregoing table it appears that the infant mortality of the urban population has relatively diminished considerably when compared with that of the State at large, — the mean rate of the thirty-one cities being only 102, as compared with 100 for the whole State, while that of the ten-year period 1881–90 was 109.

The very marked decline in the infant mortality of Boston from a comparative mortality of 17 per cent. above that of the State to 1 per cent. below it, shows a very decided improvement.

The manufacturing cities still maintain a position near the top of the list, with high infant mortality in 1896, several of them presenting even a higher rate than that of the ten-year period 1881–90.

The deaths under one reported in the foregoing table for 1896 are obtained from the statutory returns made to the Board under the provisions of chapter 218 of the Acts of 1894.

Causes of Death.

In the forty-year summary published in the last annual report the statistics of fifteen prominent causes and groups of causes of death were presented, the data given being the number of deaths from each cause in each year of the period, together with the ratio per 1,000 of the population and the percentage of the total mortality.

These tables, with those which follow them, containing the deaths by sexes, ages, months and the relative mortality of the sexes, ages and months, constitute the most valuable portion of the summary, from a sanitary stand-point, since they give the most important facts in the history of the prevalence of the diseases named for the period in question.

In the present report only a portion of these tables is repeated, the facts given being the figures for the twenty years 1877–96 only.

In the following table are presented the comparative statistics for the ten most destructive causes and groups of causes of death for the ten years 1887–96, arranged in the order of their death-rates. The five causes and groups, consumption, brain diseases, pneumonia, heart diseases and cholera infantum, appear to have maintained an almost uniformly constant relation to each other throughout the ten years.

Diphtheria and croup have dropped from the sixth place in 1894 to the seventh in 1895 and the ninth in 1896, while cancer has advanced from the tenth in 1894 to the eighth and seventh in 1895 and 1896.

Mortality from Ten Prominent Causes, 1887-96.

Causes of Death.	Deaths. 1896.	Rank — 1887-96.									
		1896.	1895.	1894.	1893.	1892.	1891.	1890.	1889.	1888.	1887.
Consumption, . .	5,536	1	1	1	1	1	1	1	1	1	1
Brain diseases, . .	5,404	2	2	2	3	2	2	2	2	2	2
Pneumonia, . . .	4,703	3	3	3	2	3	3	3	3	3	3
Heart diseases, . .	3,871	4	4	4	4	4	4	4	4	4	4
Cholera infantum, .	2,957	5	5	5	5	5	5	6	5	5	5
Kidney diseases, . .	2,009	6	6	7	8	8	8	9	9	9	10
Cancer, . . .	1,798	7	8	10	9	10	9	8	8	10	9
Old age, . . .	1,739	8	9	8	6	6	6	7	7	6	6
Diphtheria and croup, .	1,677	9	7	6	10	9	10	5	6	7	7
Bronchitis, . . .	1,452	10	10	9	7	7	7	10	10	8	8
	31,146	-	-	-	-	-	-	-	-	-	-

In the following very complete tables the populations employed as the basis of comparison are those which are presented on page xxx.

The tables will be found very useful for the purpose of comparing the mortality from different causes in different years with each other.

In the column entitled "Consumption" only those deaths are included which are registered as deaths from phthisis pulmonalis, or consumption of the lungs.

The deaths in the column entitled "Child-birth" are those which are registered as from abortion, child-birth, miscarriage, puerperal convulsions, puerperal fever, metritis, metria, puerperal septicæmia, and the excess of female deaths from septicæmia over males.

Under the title "Kidney diseases" are embraced all deaths registered as from Bright's disease, nephritis, nephria and unspecified diseases of the kidneys.

Under the title "Brain diseases" are embraced all deaths registered as from apoplexy, paralysis, insanity, softening of the brain, cephalitis, and unspecified diseases of the brain.

STATISTICS OF CERTAIN CAUSES OF DEATH, MASSACHUSETTS, 1877–96.

Deaths, and Ratios compared with Population and Total Mortality.

Years.	Small-pox.			Measles.			Scarlet-fever.			Diphtheria and Croup.			Typhoid Fever.		
	Deaths.	Death-rate per 10,000 Living.	Percentage of Total Mortality.	Deaths.	Death-rate per 10,000 Living.	Percentage of Total Mortality.	Deaths.	Death-rate per 10,000 Living.	Percentage of Total Mortality.	Deaths.	Death-rate per 10,000 Living.	Percentage of Total Mortality.	Deaths.	Death-rate per 10,000 Living.	Percentage of Total Mortality.
1877,	24	.14	.08	135	0.8	0.43	467	2.7	1.49	3,178	18.7	10.14	814	4.8	2.60
1878,	2	.01	.01	305	1.8	0.97	404	2.3	1.29	2,517	14.6	8.04	679	3.9	2.17
1879,	7	.04	.02	19	0.1	0.06	850	4.8	2.67	2,293	13.1	7.21	637	3.6	2.00
1880,	38	.21	.11	236	1.3	0.67	574	3.2	1.63	2,394	13.4	6.78	882	4.9	2.50
1881,	47	.26	.13	230	1.3	0.63	397	2.2	1.09	2,383	13.1	6.54	1,072	5.9	2.94
1882,	45	.24	.12	68	0.4	0.18	318	1.7	0.86	1,771	9.6	4.81	1,079	5.8	2.93
1883,	5	.03	.01	321	1.7	0.85	575	3.1	1.52	1,621	8.6	4.29	860	4.6	2.28
1884,	3	.02	.01	75	0.4	0.20	627	3.3	1.69	1,646	8.6	4.45	875	4.6	2.37
1885,	19	.10	.05	313	1.6	0.82	587	3.0	1.54	1,523	7.8	4.00	768	3.9	2.02
1886,	-	-	-	130	0.6	0.35	331	1.7	0.89	1,558	7.8	4.18	800	4.0	2.15
1887,	3	.01	.007	455	2.2	1.12	594	2.9	1.46	1,628	7.9	3.99	922	4.5	2.26
1888,	8	.04	.02	219	1.0	0.52	504	2.4	1.20	1,831	8.7	4.35	943	4.5	2.24
1889,	6	.03	.01	171	0.8	0.41	185	0.9	0.44	2,214	10.2	5.30	891	4.1	2.13
1890,	1	.004	.002	114	0.5	0.26	196	0.9	0.45	1,626	7.3	3.74	835	3.7	1.92
1891,	1	.004	.002	236	1.0	0.52	246	1.1	0.54	1,218	5.3	2.70	821	3.6	1.82
1892,	2	.01	.004	88	0.4	0.18	669	2.9	1.37	1,455	6.2	2.98	827	3.5	1.70
1893,	9	.04	.02	276	1.2	0.56	810	3.4	1.65	1,394	5.8	2.84	750	3.1	1.53
1894,	33	.13	.07	98	0.4	0.21	649	2.6	1.39	1,801	7.4	3.85	748	3.1	1.60
1895,	-	-	-	117	0.5	0.25	483	1.9	1.02	1,784	7.1	3.75	680	2.7	1.43
1896,	-	-	-	137	0.5	0.28	249	1.0	0.50	1,677	6.6	3.40	723	2.8	1.46
Totals and means,	253	.06	.03	3,743	0.9	0.46	9,715	2.3	1.20	37,512	9.0	4.64	16,606	4.0	2.06

STATISTICS OF CERTAIN CAUSES OF DEATH, MASSACHUSETTS, 1877-96 — *Continued.*

Deaths, and Ratios compared with Population and Total Mortality — Continued.

YEARS.	CHOLERA INFANTUM.			CONSUMPTION.			CHILD-BIRTH.				DYSENTERY.	
	Deaths.	Death-rate per 10,000 Living.	Percentage of Total Mortality.	Deaths.	Death-rate per 10,000 Living.	Percentage of Total Mortality.	Deaths.	Death-rate per 10,000 Living.	Percentage of Total Mortality.	Percentage of Births.	Deaths.	Death-rate per 10,000 Living.
1877,	1 927	11.3	6.15	5,457	32.0	17.41	275	1.6	0.88	.644	580	3.4
1878,	1,573	9.1	5.02	5,334	30.8	17.04	297	1.7	0.95	.706	602	3.5
1879,	1,349	7.7	4.24	5,223	29.7	16.42	300	1.7	0.94	.728	372	2.1
1880,	2,118	11.9	6.00	5,494	30.8	15.57	316	1.8	0.90	.700	395	2.2
1881,	1,861	10.3	5.10	5,886	32.4	16.14	370	2.0	1.01	.799	360	2.0
1882,	2,159	11.7	5.87	5,865	31.8	15.94	351	1.9	0.95	.751	398	2.2
1883,	1,941	10.3	5.14	5,931	31.6	15.71	366	1.9	0.97	.755	336	1.8
1884,	2,081	10.9	5.63	5,798	30.4	15.67	323	1.7	0.87	.649	254	1.3
1885,	1,852	9.5	4.86	5,955	30.7	15.63	350	1.8	0.92	.700	253	1.3
1886,	1,931	9.7	5.18	5,897	29.5	15.83	303	1.5	0.81	.581	243	1.2
1887,	2,131	10.4	5.23	5,871	28.6	14.40	280	1.4	0.69	.514	266	1.3
1888,	2,195	10.4	5.21	5,728	27.1	13.61	277	1.3	0.66	.491	248	1.2
1889,	2,156	9.9	5.16	5,581	25.7	13.36	303	1.4	0.73	.517	299	1.4
1890,	2,491	11.1	5.72	5,791	25.9	13.31	365	1.6	0.84	.615	220	1.0
1891,	2,771	12.1	6.13	5,484	24.0	12.14	269	1.2	0.60	.416	234	1.0
1892,	2,898	12.4	5.94	5,739	24.5	11.77	343	1.5	0.70	.508	193	0.8
1893,	2,704	11.3	5.51	5,527	23.1	11.26	317	1.3	0.65	.459	231	1.0
1894,	2,676	10.9	5.72	5,463	22.3	11.67	325	1.3	0.69	.474	216	0.9
1895,	2,377	9.5	5.00	5,486	21.9	11.54	380	1.5	0.80	.549	209	0.8
1896,	2,957	11.6	5.99	5,536	21.7	11.21	328	1.3	0.66	.453	407	1.6
Totals and means,	44,148	10.6	5.46	113,046	27.3	13.99	6,438	1.5	0.80	.596	6,316	1.5

STATISTICS OF CERTAIN CAUSES OF DEATH, MASSACHUSETTS, 1877-96 — *Concluded.*

Deaths, and Ratios compared with Population and Total Mortality — Concluded.

Years.	Pneumonia.			Whooping-cough.			Cancer.			Kidney Diseases.			Heart Diseases.			Brain Diseases.		
	Deaths.	Death-rate per 10,000 Living.	Percentage of Total Mortality.	Deaths.	Death-rate per 10,000 Living.	Percentage of Total Mortality.	Deaths.	Death-rate per 10,000 Living.	Percentage of Total Mortality.	Deaths.	Death-rate per 10,000 Living.	Percentage of Total Mortality.	Deaths.	Death-rate per 10,000 Living.	Percentage of Total Mortality.	Deaths.	Death-rate per 10,000 Living.	Percentage of Total Mortality.
1877, ...	1,972	11.6	6.29	369	2.2	1.18	646	3.8	2.06	535	3.1	1.71	1,355	8.0	4.32	2,521	14.8	8.04
1878, ...	2,171	12.6	6.93	400	2.3	1.28	807	4.7	2.58	615	3.6	1.96	1,442	8.3	4.61	2,778	16.1	8.87
1879, ...	2,647	15.1	8.32	302	1.7	0.95	862	4.9	2.71	693	3.9	2.18	1,515	8.6	4.76	2.820	16.1	8.87
1880, ...	3,076	17.3	8.72	230	1.3	0.65	928	5.2	2.63	698	3.9	1.98	1,726	9.7	4.89	3,210	18.0	9.10
1881, ...	2,967	16.4	8.14	217	1.2	0.59	949	5.2	2.60	825	4.5	2.26	1,937	10.7	5.31	3,355	18.5	9.20
1882, ...	2,932	15.9	7.97	265	1.4	0.72	987	5.3	2.68	877	4.7	2.38	2,025	11.0	5.50	3,393	18.4	9.22
1883, ...	3,045	16.2	8.07	137	0.7	0.36	1,026	5.5	2.72	959	5.1	2.54	2,153	11.5	5.70	3,562	19.0	9.44
1884, ...	2,646	13.9	7.15	410	2.1	1.11	1,060	5.6	2.87	1,000	5.2	2.70	2,117	11.1	5.72	3,669	19.2	9.92
1885, ...	3,468	17.9	9.10	184	0.9	0.48	1,087	5.6	2.85	1,088	5.6	2.86	2,227	11.5	5.85	3,894	20.0	10.22
1886, ...	2,836	14.2	7.61	271	1.4	0.73	1,104	5.5	2.96	1,135	5.7	3.05	2,325	11.6	6.24	3,844	19.2	10.32
1887, ...	3,348	16.3	8.21	232	1.1	0.57	1,174	5.7	2.88	1,120	5.4	2.75	2,690	13.1	6.60	4,257	20.7	10.44
1888, ...	3,716	17.6	8.83	245	1.2	0.58	1,275	6.0	3.03	1,318	6.2	3.13	3,061	14.5	7.27	4,522	21.4	10.74
1889, ...	3,440	15.8	8.23	310	1.4	0.74	1,325	6.1	3.17	1,258	5.8	3.01	3,280	15.1	7.85	4,313	19.8	10.32
1890, ...	4,038	18.0	9.28	363	1.6	0.83	1,387	6.2	3.19	1,273	5.7	2.92	3,417	15.3	7.85	4,389	19.6	10.08
1891, ...	4,337	18.9	9.60	219	1.0	0.48	1,395	6.1	3.09	1,474	6.4	3.26	3,592	15.7	7.95	4,711	20.6	10.43
1892, ...	5,020	21.5	10.30	248	1.1	0.51	1,402	6.0	2.88	1,535	6.6	3.15	3,733	16.0	7.65	5,036	21.5	10.33
1893, ...	5,499	23.0	11.20	274	1.1	0.56	1,533	6.4	3.12	1,685	7.0	3.43	3,511	14.7	7.15	5,144	21.5	10.48
1894, ...	4,101	16.8	8.76	435	1.8	0.93	1,568	6.4	3.35	1,721	7.0	3.68	3,432	14.0	7.33	4,995	20.4	10.67
1895, ...	4,652	18.6	9.79	269	1.1	0.57	1,749	7.0	3.68	1,860	7.4	3.91	3,566	14.3	7.50	5,062	20.2	10.65
1896, ...	4,703	18.4	9.52	282	1.1	0.57	1,798	7.0	3.64	1,945	7.6	3.94	3,664	14.3	7.42	5,404	21.2	10.95
Totals and means,	70,614	17.0	8.74	5,662	1.4	0.70	24,062	5.8	2.98	23,614	5.7	2.92	52,768	12.7	6.53	80,879	19.5	10.01

Water Supply and Sewerage.

The general act relating to the protection of the purity of inland waters (chapter 375 of the Acts of 1888) furnishes the legal authority under whose provisions the operations of the engineering department of the Board are conducted. This law was first enacted in 1886, and was amended two years later by a provision requiring that all petitions to the Legislature for authority to introduce systems of water supply and sewerage should be accompanied with the advice and recommendation of the Board. The usefulness of the act is universally acknowledged, and every year many inquiries from other parts of the Union are received relative to the operation of this law, and delegations from distant States and cities come to Massachusetts to obtain information as to the work of the laboratories, the experiment station at Lawrence, and the operations of the different filter plants now being conducted by the local authorities in various towns in the State for the filtration of sewage and water.

During the year 1897 fifty-nine applications were officially made to the Board for its advice under the provisions of the act referred to, making in all 508 such applications since the enactment of the statute in 1886. These applications were made by the accredited authorities of cities, towns, corporations and in a few instances by individuals.

The advantage of such an act, whereby all important public works of this character may have the advantage of systematic supervision by a central authority, has in this Commonwealth been fully demonstrated. Pure supplies of public water and efficient systems of sewage disposal have a direct effect upon the public health, and result in the saving of life. It is estimated that at least 160 lives have been saved in the city of Lawrence alone by the method of water filtration there employed, as advised by the Board, since 1893.

The detailed statement of the work of the Board in this department for the year 1897, presented in this report, consists of the following topics. First, advice to cities and towns, being the principal portion of Senate Document 4, which was presented to the Legislature in January, 1898. Second, the examination of water supplies. In this portion may be found the results of the chemical and microscopical examinations of the water supplies of the State conducted in 1897. Descriptions of new works and changes in existing works are also presented in this part of the report. Third,

examination of rivers not used as sources of water supply. Fourth, summary of water supply statistics. Under this topic it is shown that there are now 159 cities and towns in the State which have a public water supply, and there are only 10 towns having a population of more than 3,000 which have no public supply. Fifth, the report of the chemist in charge of the Lawrence Experiment Station presents the results of experiments upon sewage and water filtration. The experiments of the previous year upon the filtration of the sewage of manufactories (tanneries, paper mills and wool-scouring establishments) have been continued. New lines of investigation have been conducted in the filtration of highly polluted waters, and in the removal of iron in such forms as it is occasionally found to exist in different waters of the State. Sixth, a brief statement is made of the sewage disposal works now in operation, together with the results of examinations of the sewage and of the effluents from the filter-beds.

The Restoration of Green Harbor.

By the provisions of the following section (chapter 495, Acts of 1896, section 1) the Harbor and Land Commissioners and the State Board of Health were made a joint board to report upon the restoration of Green Harbor in the town of Marshfield: —

Section 1. The board of harbor and land commissioners and the state board of health, acting as a joint board, are hereby required to cause an examination of Green Harbor in the town of Marshfield, and of the Green Harbor marshes and the dam and dike constructed across Green Harbor river under the provisions of chapter three hundred and three of the acts of the year eighteen hundred and seventy-one, to be made by competent engineers, who shall report to said joint board the result of their examination; and if upon receiving such report said joint board shall determine that a substantial improvement in and benefit to Green Harbor will result from the removal of said dam and dike, and that no damage to vested property rights greater than the benefit and improvement to be derived from such removal will result therefrom, then the board of harbor and land commissioners shall remove said dam and dike, and shall replace such portion of the highway as may be destroyed by such removal, by a suitable bridge, either with or without a draw, as said board of harbor and land commissioners may determine that public convenience requires. The joint board and the board of harbor and land commissioners shall make a full report of their doings under this act to the general court at the next session thereof.

The time allowed by the foregoing statute having been found insufficient for making the required examinations, it was extended by the Resolves of 1897, chapter 98, until the first Wednesday in January, 1898, at which time the following report was presented to the Legislature: —

REPORT OF THE JOINT BOARD UPON THE RESTORATION OF GREEN HARBOR IN THE TOWN OF MARSHFIELD.

To the Honorable the Senate and House of Representatives of the Commonwealth in General Court assembled.

In accordance with the provisions of chapter 495 of the Acts of 1896, the Board of Harbor and Land Commissioners and the State Board of Health met on July 15, 1896, for the purpose of organization as a Joint Board. Henry P. Walcott was elected chairman, Frederick N. Wales was appointed secretary, and Frank W. Hodgdon, C.E., and X. H. Goodnough, C.E., were directed to make an examination of Green Harbor and of the Green Harbor marshes and the dam and dike constructed across Green Harbor River, and to report to the Joint Board the result of their examination.

The Joint Board has personally inspected the localities concerned, has held a public hearing at Green Harbor, has caused experiments to be made in order to discover the probable results of again subjecting the marshes above the dike to the direct influence of the waters of the ocean, and has gathered all the facts available which show the influence of the existing conditions upon the health of the neighborhood.

The engineers of the Board proceeded at once to undertake the examinations called for in chapter 495 of the Acts of 1896. They prosecuted their inquiries with commendable diligence, and have presented to the Joint Board their final reports. After careful consideration of the reports, it was unanimously voted, on Dec. 9, 1897, "That, in the judgment of this Joint Board, the Green Harbor dike, so called, should not be removed, and that a report to the General Court be made upon the basis of this judgment and vote."

The reasons which led the Joint Board to this conclusion are contained in the following pages.

The Board was directed by the above-mentioned act to settle two questions; first, whether a substantial improvement in and benefit to Green Harbor would result from the removal of said dam and dike; and, second, whether the damage to vested property rights would be greater than the benefit and improvement to be derived from such removal.

The small village of Green Harbor is situated in the south-easterly portion of the town of Marshfield, at the mouth of the Green Harbor River. The permanent population of the region lying about Green Harbor is not

large, — probably less than 200, — but the attractions of the place are sufficient to bring here in summer nearly 2,500 temporary residents. Marshfield itself had, by the State census of 1895, a population of 1,760. In 1840 it had a population of 1,761.

The region about Green Harbor was occupied by settlers from Plymouth soon after the establishment of the Colony, and in the Court Records, under date of July 1, 1633, appears the following entry : —

That unless Mr. Gilson, John Shaw and the rest that undertooke the cutting of the passage between Green's Harbour and the bay, finish it before the first of October next ensuing, according to covenant, they be amerced in ten pounds; but if any of them will doe it, the fine be exacted of the rest, and they paid for their labour.

Early in 1636 there is another order of the court, that the cut at Green's Harbor for a boat passage be made 18 feet wide and 6 feet deep, and the governor, with certain assistants, was authorized to direct the work. The cut referred to in these extracts is evidently a channel cut to enable boats to pass from Plymouth harbor to Green Harbor River, and thereby avoid going outside the Gurnet.

In 1785 a petition was presented to the General Court asking for an act to prevent the use of Marshfield beach for grazing purposes. No act was granted at this time, but in connection with this petition a copy of a will was presented, in which the marsh lands in the vicinity of Bass Creek a tributary of the Green Harbor River, entering it about a mile above the dike, are referred to as "salt marshes." No further reference that is of interest in connection with Green Harbor is found in the Colonial Records.

Upon the map of Marshfield made in 1794, on file in the department of the Secretary of the Commonwealth, the mouth of Green Harbor River is shown to be about five-eighths of a mile south of its present outlet.

The first mention of Green Harbor that is of interest in the Acts and Resolves of the State is in 1807, when an act was passed to establish a corporation for the purpose of draining Green's Harbour marsh, so called, in the town of Marshfield. The petition for this act appears to have been presented to the House of Representatives on May 29, 1806, and is as follows : —

To the Honorable the Senate and House of Representatives of the Commonwealth of Massachusetts, in General Court assembled —

The subscribers, owners and occupants of certain meadows, lying in the town of Marshfield in the county of Plymouth humbly represent, that whereas a certain River, called Green's Harbour River in said town of Marshfield has in times passed afforded an outlet to the waters, which have overflowed about two thousand acres of said marsh, and whereas lately the mouth of said River has been closed, by beach sand, confining a great body of water on said marsh, which may prove entirely destructive of said meadows and it has become absolutely neces-

sary that said water should be drawn of in the most convenient manner possible, and Whereas, we the subscribers, owners and occupants of the marsh aforesaid, for the preservation of the same, have associated for the purpose of draining said waters from said marsh into Duxboro Bay, by digging a canal for said water and having in said enterprise expended about the sum of three thousand dollars for the purpose aforesaid, pray the Honorable Court that we and our associates may be incorporated into a Body Politic, to manage the above undertaking and be possessed of all the powers and privileges, usually granted to similar incorporations and as in duty bound will ever pray — (Signed) Isaac Winslow, and others.

In response to this petition, chapter 39 of the Acts of 1807 was passed, on Feb. 11, 1807, incorporating the Green's Harbour Canal Company for the purpose of draining Green's Harbor marsh in the town of Marshfield. Section 1 of this act is as follows: —

Be it enacted by the Senate and House of Representatives in General Court assembled, and by the authority of the same, That Isaac Winslow, Luke Wadsworth, Judah Thomas and Benjamin White, proprietors in Green's Harbour Marsh in the town of Marshfield, together with their associates, and such others as may hereafter associate with them and their heirs and successors, shall be a Corporation by the name of Green's Harbour Canal Company, with all the powers and privileges incident to similar Corporations, for the purpose of draining the stagnant water of Green's Harbour Marsh in the town of Marshfield and for better improving said Marsh, by erecting dikes or removing bars of sand, rocks or other obstructions that oppose the draining of said marsh, for digging a canal or canals for said water to pass into Duxbury or Plymouth Bay, and building a bridge or bridges across said canal or canals, if the same should intersect any private or public highway, and by the name aforesaid, may sue or be sued, and do and suffer, whatever other similar Bodies Politic may or ought to do and suffer.

In 1812 another petition was presented to the Legislature by the Green's Harbour Canal Company, relative to the preservation of Marshfield beach, which had been the subject of legislative consideration in 1785. The petition of the Green's Harbour Canal Company is dated May 23, 1812, and is as follows: —

To the Honorable Senate and the Honorable House of Representatives of the Commonwealth of Massachusetts in General Court assembled.

The petition of the Green's Harbour Canal Company in the County of Plymouth — Humbly shews, — that the said Company are Proprietors of a certain Tract of salt Marsh-land, lying in the town of Marshfield in said County of Plymouth — that said Marsh is defended from the Sea, on the Northeast, by a Beach called Marshfield Beach — that Anno Domini 1806 the River called Green's Harbour River, which runs thro' said Marsh and Beach into the Sea, was filled up with Sand, by a violent Storm which caused the whole Marsh, together with the low Land contiguous thereto, to become a Lake, by estimation, of about 2000 acres of stagnant Water — that, on this emergence your Petitioners were obliged to

open a Canal into Duxbury Bay and build a bridge over the same; which cost them nearly 2000 Dollars — the Canal answered a good Purpose for draining the Marsh; but did not admit sea water enough into the Marsh, to preserve it, in its former State; some Parts thereof producing Rank Weeds of various kinds, and other Parts Nothing at all — Anno Domini 1811, another violent Storm forced a new Channel or River thro' said Beach, at a considerable distance from where the former River was filled up, and said Channel now remains, sufficient it is said, at full Tide, for a Vessel of 100 Tons to enter — that there are now some Places in the Beach, the whole length thereof being about 5 Miles, so low that the tides, when in a Course to be high, flows across them into the Marsh — That there often are Cattle ranging up and down the Beach and Horses turned out to graze thereon, by Gunners and Fishermen who resort there; by which means not only the Tops of the Grass are taken of; but the Roots so started and the Sand so loosened that the Wind has more Power to level the Beach — That there has been some Labour taken to hedge the Beach with Brush, which has been found ineffectual, the Cattle frequently levelling it with their Horns, out of mere Frolic — That the damage to said Company on account of the Loss of the Produce of said Marsh, has been equal if not greater than the cost of opening the Canal — That it is a Public Damage is certain, especially to the back Towns in the Vicinity, as they were usually relieved, in some measure, by our Salt Hay, when their English was cut short by Drought etc., — That the Whole number of the said Proprietors is about 120, and that about one half of them do not reside in Marshfield, for which Reason it was thought most proper for the Proprietors to Petition, and not the Town — That said Company do not wish to deprive any Individual or Individuals of any legal right they have in said Beach, without an adiquate compensation therefor — For the foregoing reasons, and some others that might be offered, your Petitioners humbly pray that this Honorable Legislature would be pleased to take their embarassed situation into serious consideration, and grant them relief by some special Law or Act, as in their Wisdom they may judge best for the Preservation of said Beach, it being, as they are told, the only Beach in the Vicinity, if not in the State that is destitute of a special Law to preserve it — So shall ever pray as in Duty bound

Marshfield, May 27, 1812. (Signed) LUKE WADSWORTH,
Agent of Green's Harbour Canal Company.

The petitioners were given leave to withdraw, and nothing more with reference to Green Harbor appears until June, 1826, when a petition of the inhabitants of the town of Marshfield was presented to the Legislature as follows: —

To the Honorable Senate and House of Representatives of the Commonwealth of Massachusetts, in General Court assembled, June A.D., 1826.

The petition of the inhabitants of the town of Marshfield in the County of Plymouth — Humbly showing — That said town is bounded easterly about 5 miles by the Sea or Bay of Massachusetts, between Duxbury and Scituate — that there is two valuable tracts of salt Marsh or Meadow, containing between 2,000 and 3,000 acres, together with a considerable quantity of low land contiguous thereto; all of which is defended from the sea, by a beach and two islands; the one called Hewett's and the other Branches Island — that, of late years, the said beach has been in a shifting and uncertain state — that, at one time the mouth of the River,

called Green's Harbour River, that runs through the marsh and beach into the sea, is choked or stopped up, by a bar of sand, and the meadow becomes a lake — that, at another time, the flood breaks or bursts through the beach, and opens a new channel or river in a place where there was never one before, since the memory of man — that the mouth of said River is now so wide that it admits, or lets in, so much tide, that it is difficult to make the hay on the meadow — And that, in the winter before last past, there was so much tide forced through the mouth of the river and over the beach at other places, in the time of a storm, that the greatest part of the stacks of hay, were taken off the stadles and carried on the upland and into the swamps adjacent — And as it is the general practice in this Commonwealth, to make application to the General Court for a special act or law to preserve and secure from damage beaches like circumstanced with ours, we therefore humbly pray this Honorable Court, to grant us an act or law to preserve and secure from damage the whole of Marshfield Beach, excepting the seashore lying directly between the aforesaid Islands and the Sea; and that said law relative to Marshfield Beach may be, in general, similar to the law granted to the inhabitants of Duxbury, relative to Salter's Beach, A.D. 1808; in particular as it respects the prohibition of grazing that beach. —

So, as in duty bound, shall ever pray, the Inhabitants of Marshfield — (Signed) LUKE WADSWORTH, *Agent.*

A remonstrance was presented to the General Court in January, 1827, which is of interest in this connection, and is as follows: —

To the Honorable the Senate and House of Representatives of the Commonwealth of Massachusetts in General Court assembled.

The subscribers inhabitants of the town of Marshfield in the county of Plymouth ask leave respectfully to remonstrate against the petition of Luke Wadsworth agent for said town, now pending before your Honorable Body, to the extent and for the reasons here assigned.

The necessity and propriety of having something done for the preservation of a part of Marshfield Beach is admitted. But about one half of said beach is flanked on the inside by elevated and rocky upland; and most of the residue has, ever since the memory of man, 'till within a few years, been preserved by means of a hedge erected and maintained thereon by the adjacent meadow owners; and the experience of more than 100 years has tested and established the efficacy and economy of this mode of security. For the past 10 or 15 years, however, the hedge has been entirely neglected and during that period, the encroachments of the sea on the beach have been constant and perceptible. But although cattle have been permitted time out of mind to graze thereon, until the neglect of the hedge as aforesaid, no alarming or dangerous inroads were ever made by the sea. And in April last the gaps in said beach laying between Major Thomas' farm and Hewett's Island about one mile in length amounted in extent to about 80 rods and were hedged at an expense of about $30 or $40, and the effect of one season thereon has demonstrated anew the entire efficacy and economy of this mode of defence.

The herbage of said beach is valuable. Portions thereof are, as we are informed, claimed as the fee simple estate of the adjacent upland owners, and the right of feeding the whole thereof is claimed by different individuals as their

right. If then cattle are excluded therefrom, we apprehend the town would be unavoidably involved in much and expensive litigation; and if ultimately compelled to make good all injury to individuals, we see not how the town can escape from the payment of heavy damages.

Under these circumstances we do most respectfully remonstrate against the passage of an act to exclude cattle from said beach as altogether unnecessary and inexpedient, because another and much cheaper mode of defence may be adopted, which experience has shown to be effectual.

And as in duty bound will ever pray, (Signed) JOSEPH CLIFT, Jr.
JOTHAM TILDEN and others.

An act was passed Feb. 21, 1827, being chapter LXXXI. of the Acts of that year, giving the inhabitants of the town of Marshfield authority to build a sea-wall, palisades or hedge fences to preserve and secure the whole of Marshfield Beach from incursions and encroachments of the sea, excepting the seashore lying directly between Hewett's and Branch's islands and the sea, and granting authority also to keep the same in repair. Another section of the act provided that no cattle, horses, sheep, etc., should be admitted to go at large on the beach.

On Dec. 14, 1829, the Green's Harbor Canal Company petitioned to be dissolved, stating that the purposes for which the said corporation was created had been effected so far as the same were practicable, and that their continuance as a corporate body was useless, and productive only of unnecessary trouble and expense. A remonstrance was received from the town of Duxbury, setting forth the value of the canal into Duxbury Bay for their use in transporting timber, hay and other materials; but an act was passed March 16, 1831, dissolving the Green's Harbor Canal Company.

A map of the town of Marshfield, dated 1831, and on file in the archives of the Secretary of the Commonwealth, shows the mouth of the river at approximately the same location as it is found to-day, but this map gives no details of importance.

The evidence is conclusive that the mouth of the river was in 1794 about five-eighths of a mile south of its present location; and the statements made by petitioners and not denied by remonstrants indicate that this outlet was closed by sand not long previous to May, 1806, when the petition was presented to the Legislature for the incorporation of the Green's Harbor Canal Company. No information is furnished, however, as to the depth of the mouth of the river, but it is stated in a note that its width just above its mouth was about 8 rods, though it widened quickly inside to 60 rods. Another note upon the plan of 1794 states that it was full sea at a point a short distance below Green Harbor bridge near the upper end of the marsh about two hours later than at the seashore, indicating that the tide was retarded considerably in its flow up the stream, which was probably principally due to obstruction at the outlet, though it may have been due

to obstruction further up stream. It appears from the petition for the incorporation of the Green's Harbor Canal Company that the mouth of the river was closed by sand during a violent storm a short time previous to May, 1806, and that for a period of four or five years succeeding this time the mouth of the river remained closed; but from a petition of the Green's Harbor Canal Company in 1812 and from other information it appears that a new channel was opened by the sea in the latter part of 1810 or early in 1811, and that the new channel was approximately at the place where the mouth of the river is found at present. This channel was said to be in 1812 sufficient, at full tide, for a vessel of 100 tons to enter. Tradition seems to indicate that this channel was begun artificially. The next recorded statement as to the condition of the river is found in the petition of June, 1826, quoted above, alleging that the mouth of the Green Harbor River had of late years been in a shifting and uncertain state, being at one time choked by a sand-bar and at another time being open freely. The petition of the Green's Harbor Canal Company for dissolution in 1829 states that the drainage of the marshes, for which purpose the company had been incorporated, had been effected as far as practicable. The map of Marshfield, dated 1831, as already stated, shows the mouth of the river at about the same location as it is found to-day, but gives no details of importance.

The next information found relative to this harbor is the work of the United States Coast Survey. Soundings were taken along the coast in this region in the years 1854 and 1855, and the first complete topographical map of the coast was made in 1857; copies of the plans of these surveys have been obtained from that department. The sheet showing the soundings is plotted to a scale of 1 in 80,000, or about 6,667 feet to an inch, and only two or three soundings are shown in the vicinity of the mouth of the river. One of these soundings, located at the outer end of the present channel, showed a depth of 1 foot at low water. The chart of this coast, based on this survey, shows a depth of 1 foot at low water at the outer end of the harbor. The topographical survey was plotted on a scale of 1 in 10,000, or $833\frac{1}{3}$ feet to an inch, and shows the mouth of the harbor substantially in its present position. The high and low water lines of the harbor are shown from its outlet for a long distance up through the marshes, but no soundings are given, and it does not appear that any were made.

In 1870, when the question of reclaiming the marshes was under consideration, examinations, surveys and some tidal and current measurements were made under the direction of the United States Coast Survey by Assistants Henry Mitchell and H. L. Whiting; but it does not appear that any soundings of the harbor or any surveys of its contour were made at this time. The only records of this work which were found are contained in the report of the United States Coast Survey for 1869; and it is stated by the superintendent, in reply to a request for additional information,

that nothing further is on file in the office of the survey than the report referred to.

Extracts from this report are published in the fifth report of the Harbor Commissioners, dated January, 1871, and from this report the following extract of a statement by Professor Mitchell with regard to the harbor is taken: —

The lower reach of the river is known as Green Harbor, whose length from Turkey Point to the bay is about $\frac{7}{8}$ of a mile and whose maximum low water width scarcely exceeds 500 feet. A sand bar obstructs the entrance, upon which there is from 2 to 3 feet of water at ordinary low tide, the average rise being 9 feet, and vessels can take the ground within the harbor at low tide without injury.

In the report of Professor Whiting is found the following statement: —

As a small local harbor it also has some character. Once within the mouth of the river, a small vessel would find good anchorage, sufficient depth of water and complete shelter. The entrance, however, is shoaler than the river within, and really cannot be called navigable at low water.

The dike was completed in the year 1872, at a cost of $32,090.79, and subsequently in 1879 was widened to carry the road from Green Harbor to Brant Rock.

The Acts of 1871 authorized the construction of a dam and dike across Green Harbor River for the purpose of "improving the Green Harbor marsh in the town of Marshfield and for other purposes." Following the building of the dam and dike came certain changes in the small harbor at the mouth of the river. The effect of these changes was a serious one for the fishermen of the village, and in the course of years much feeling has arisen between the parties in the town, composed respectively of those in favor of the dike and of those opposed to it and in favor of its removal.

In view of the directions of the Legislature to deal with a condition of things which we find to be now in existence, it is fortunately unnecessary for us to rehearse the long story of this the most stirring episode in the history of this peaceful New England village.

It is undoubtedly true that this small harbor has deteriorated since the building of the dike, and we believe that the dike is responsible for a portion of the mischief done; but, as will be seen by the brief statement of the history of this river, it is not clear that the harbor has been at any time safe from a calamity similar to that which befell it in the earlier years of the century. That such catastrophes in harbors of this character are not uncommon may be learned from the history of the North River, only a few miles distant from this place.

The changes which have taken place over the meadows above the dike are fully as important as any which have been observed in the harbor, and might easily become a source of danger to the communities around the harbor of far greater moment than the shoaling of the waterways.

The Green Harbor marshes, like all others of the same composition, shrink rapidly when drained, and this shrinkage has a tendency to continue until the surface approaches the permanent water level, and obtains a consistence dense enough to resemble the conditions of ordinary cultivable soil. The amount of subsidence depends mainly upon the more or less spongy character of the marsh.

When the salt water of the soil is replaced by fresh water, the larger portion of the vegetation peculiar to salt marshes disappears, the roots decay after the lowering of the water level, still further increasing the shrinkage, and then come the grasses and plants adapted to fresh-water areas.

All the evidence in our possession shows that this subsidence has taken place all over the marshes located above the dike, ranging in amount from a few inches to several feet. It appears that an area of 1,334.3 acres, excluding water surfaces, would be covered by every mean high tide in case the dike should be removed.

The first effect of such applications of salt water to this surface would be the prompt destruction and decay of the fresh-water vegetation now established here, and then would come a period of uncertain duration, when there would be little or no vegetation, but only an expanse of unsavory mud flats, emitting foul odors.

It might then be possible that the thriving settlement along the Marshfield beach to the east of this great expanse of mud flats, and exposed to all the smell brought over by the western breezes, would have some reason to complain that the Commonwealth had not equally guarded all the varied interests in this community.

The removal of the dike would not by any means restore a condition of things existing before the construction of this barrier. An amount of water far in excess of anything before known would tear through the light sands which form the margins of the harbor, and produce effects which cannot easily be measured, but which we have every reason to suppose would be disastrous.

A number of houses have been built on land formed since the dike was built in the vicinity of the northerly end of Duxbury Beach. We have every reason to suppose that this sand bank could not withstand the eroding action of currents far stronger than any that existed in the days when a smaller volume of water prevented this encroachment on the waterways.

For the purpose of ascertaining the conditions of healthfulness in this district, we have caused tables to be prepared, showing the causes of deaths and the death rates for a period of thirty years; but we cannot discover in these tables satisfactory evidence of the existence of conditions prejudicial to health. The average death rate for the whole period has been 17 per 1,000, which is below the general death rate of the State for the same period. The well-founded belief of the people in the present health-giving qualities of this region is shown by the steady increase in

summer visitors and by the many houses built in the immediate vicinity of the harbor and river.

The builders of the dike were sanguine in their expressions of belief in the value of the reclaimed marshes for agricultural purposes; but we find many residents of Green Harbor who have serious doubts as to the real value of these fields. We were fortunately able to draw to our assistance Edmund Hersey, Esq., of Hingham, whose wide experience and ample knowledge in the science and art of agriculture have made him a much valued authority in this department.

Mr. Hersey's report showed very conclusively that the value of the marsh lands above the dike was greatly increased since the construction of the dike.

The act under consideration requires the Board of Harbor and Land Commissioners to remove the dam and dike, in case the Joint Board shall determine that a substantial improvement and benefit to Green Harbor will result therefrom, and that no damage to vested property rights greater than the benefit and improvement from such removal will accrue therefrom.

We are thus led to consider, first, what are the damages to vested property rights. It is found that the marshes which were flowed by tide waters before the building of the dam have shrunk and become lowered, in places varying from a few inches to half tide line. In allowing the tide waters to flow in over this area by the removal of the dam, this lowered area would be covered by salt water for so long a period over every tide that vegetation would be destroyed, and the area, as land, would be changed into mud flats, and become practically valueless. We are informed that about 1,031 acres of this marsh area is appraised, for the purposes of taxation, at $22,335. In view of Mr. Hersey's statements this must be considered a very low estimate; but applying this rate to the 1,334.3 acres which would be submerged, we have an appraisal of $28,900. The greatly increased volume of the ebb tide would require a wider as well as deeper outlet, and in making it the water would probably wash away the point jutting into the harbor from the south as far back as the bridge over Cut River, an estimated area of about 300,000 square feet, and with it some 25 cottages and a hotel, all valued at about $12,000.

The removal of the dam and dike and the substitution of a bridge suitable to replace such portion of the highway as may be destroyed, is estimated to require $27,200. The introduction of the increased volume of water, which, owing to the lowering of the meadows, would be considerably greater than before the building of the dam, would be attended by other unknown and possibly considerable injury to property, even though its flow were guided and controlled in a manner designed to avert the chances of unnecessary damage.

It cannot be foreseen in what precise locations or to what depth the ebbing tide of so great a body of water might disturb existing conditions. To guard against these possibilities and limit the course of the stream to

insure a deep channel instead of a wide shallow channel, the construction of a jetty or training wall is undoubtedly necessary. The cost of this may be estimated to be not less than $40,000. The total expenditure, therefore, incident to the removal of the dam and dike, may be estimated to be the damages for the property injured, the cost of removing the dam and building a bridge, and the cost of a training wall or jetty to control the direction of the ebb tides. These items together, excluding the damage to the meadows, will amount to at least the sum of $79,200.

The removal of the dike, however, is fortunately not the only solution of the problem. The mouth of Green Harbor empties into Massachusetts Bay in a general south-easterly direction. On the north-east it is protected by a point of rocks. The movement of the shore current which bears along the drift is from the south, and this has a tendency to close the river mouth. The dash of the waves in heavy weather, especially in south-easterly storms, brings more or less sand into the harbor. From the north-easterly storms the rocky promontory affords the harbor adequate protection.

The material which has filled up the harbor has probably come in from the outside from the south and south-east. The ebb current from Green Harbor proper has not been strong enough to preserve a channel of sufficient depth at low tide to answer the requirements of the vessels which anchor there. Under present conditions there is no reason to look forward to any improvement in the depth of the interior basin or the channel. Any change is more likely to result in gradual shoaling. A plan for improving this condition has been developed which it is believed will successfully preserve the usefulness of the harbor and increase its depth of water, both at the entrance, where a depth of from 30 inches to 4 feet at mean low water is desired, and in the harbor above, where the boats lie at their moorings.

This plan is to dredge an anchorage basin with a channel thereto, and to build two jetties and a training wall. An anchorage basin can be built above the Narrows by the dredging of an area of 90,000 square feet, which would be sufficient for all present requirements, and a channel dredged thereto from the sea, 50 feet wide at the bottom, leaving a depth on dredged areas of 4 feet at mean low water. In order to preserve this channel, it would be necessary to build a stone jetty from Duxbury Beach to deep water, to protect it from the sand drift and wave dash on the south and south-east. A small jetty on the north, running from the rocky point, would afford an additional means of maintaining the depth of the channel. In addition thereto, a training wall should be built inside the harbor to deflect and guide the current at the mouth of Cut River.

It is estimated that all of the work so planned will cost about $67,000.

By comparing this amount with the expense necessarily incident to the removal of the dam and dike, which, as above stated, amounts to $79,200, exclusive of the damage to the meadows, it will be seen that there will even be a saving in cost by constructing a harbor as proposed and leaving the

dike undisturbed; but when we take into consideration the unknown and inevitable elements of damages, which must be considered if the dike is removed, the difference becomes a very serious one.

These elements of damages are found first in the diminution of health and attractiveness in the settlements along Marshfield beach, by reason of the foul odors brought over from the mud flats created by the flooding of the meadows to the west of them which are now below the level of high tide, and then by the absolute destruction of the fertile meadows which have been reclaimed by means of the dike. How large a sum of money is represented by these injuries, which will surely, we think, follow the removal of the dike, we are unable to estimate; but it will undoubtedly very much exceed the expenditure necessary to make a harbor sufficient for all the purposes of a fishing village, or an agreeable seaside resort.

We are then constrained to determine that the damage to vested property rights that would result from the removal of said dam and dike would be far greater than the benefit to Green Harbor resulting therefrom.

HENRY P. WALCOTT, *Chairman*.

WOODWARD EMERY,
CLINTON WHITE,
Board of Harbor and Land Commissioners.

HIRAM F. MILLS,
FRANK W. DRAPER,
GERARD C. TOBEY,
JAMES W. HULL,
CHARLES H. PORTER,
JULIAN A. MEAD,
State Board of Health.

BOSTON, MASS., Jan. 5, 1898.

Financial Statement.

Expenditures made under Chapter 495, Acts of 1896, and Chapter 98, Resolves of 1897.

Salaries of engineers, experts and assistants,	$7,750 43
Travelling expenses and subsistence of engineers, experts and assistants,	1,100 75
Labor, materials and supplies,	248 37
Travelling expenses of Joint Board,	105 18
Services of stenographers and typewriters,	129 10
Rent, fuel and use of boats,	190 85
Repairing instruments and tools,	29 70
Expressage and telephone,	31 99
Stationery, maps, postage and drawing materials,	46 55
Advertising,	12 70
	$9,645 62

Routine Work of the Board.

During the year ending Sept. 30, 1897, the Board held meetings at least once in each month. Meetings of such of the standing committees as were necessary for the transaction of business were also held from time to time, as well as joint sessions with such other boards or commissions as were prescribed by the Legislature.

The office of the Board has been open throughout the year, as prescribed by the Public Statutes, chapter 21, section 10,* for the transaction of its authorized business.

Advice has been very frequently given at the office and by mail to local boards and to individuals in regard to sanitary matters, and many visits have been made by the secretary, the engineers and other experts to cities and towns for the purpose of making investigations and giving advice.

The bacteriological work undertaken by the Board for the benefit of such committees in the State as possessed no facilities for such methods of investigation and diagnosis, together with the production and distribution of antitoxin for the treatment and prevention of diphtheria, have very materially increased the work of the office, which acts as a general and central station for the distribution of antitoxin and of the various culture tubes, receptacles and other means employed for the diagnosis of disease.

The statistics of mortality compiled from the weekly postal-card returns from the registering authorities of cities and towns have been published weekly during the year in the form of a bulletin, which also contains, once in each month, a report of the work done in the line of food and drug inspection, together with the prosecutions made under the food and drug acts, and other important information relative to the work of this department. In addition to these items there is also published in the same bulletin a weekly report of the number of cases of infectious diseases reported by the local boards to the State Board of Health, under the provisions of chapter 302 of the Acts of 1893.

The laboratory for water analysis was transferred in January, 1897, from the Institute of Technology to No. 502 State House, where ample provision had been made for this work upon the fifth floor of the new extension, above the archway over Mt. Vernon

* Office hours, 9 A.M. to 5 P.M.; Saturdays, 9 A.M. to 2 P.M.

Street. Mr. H. W. Clark, chemist of the Board, who for several years had charge of the laboratory of the Lawrence Experiment Station, was subsequently placed in charge of the laboratory at the State House also.

The following table presents certain statistical data relative to the routine work of the Board: —

Statistical Table for the Year ending Sept. 30, 1897.

Whole number of samples of foods and drugs examined during the year,	10,680
Samples of milk examined (included in the foregoing),	6,046
Whole number of samples of food and drugs examined since beginning of work in 1883,	86,793
Whole number of samples of milk examined since beginning of work in 1883,	44,951
Number of prosecutions against offenders during the year,	65
Number of convictions during the year,	64
Amount of fines imposed during the year,	$2,756 60
Number of packages of antitoxin issued to cities and towns,*	4,668
Number of bacterial cultures made for the diagnosis of diphtheria in cities and towns,*	2,204
Number of examinations made for diagnosis of tuberculosis,*	236
Number of examinations of blood made for diagnosis of malarial infection,*	72
Number of notices of cases of infectious diseases received and recorded under the provisions of chapter 302, Acts of 1893,†	27,925
Number of postal card returns of mortality for cities and towns received and recorded,†	1,910
Number of annual reports of cities and towns received under the provisions ‡ of Acts of 1894, chapter 218,†	86

Force employed in general work of Board at central office, State House: —	
Secretary,	1
Clerks,	2
Messenger,	1
Total,	4

Force employed at central office, State House, Boston, for food and drug inspection, chemists and assistants,	2
At Amherst,	1
Inspectors,	3
Total,	6

* For the year ending March 31, 1898. † For the calendar year 1897.

‡ Towns having a population of over 5,000 inhabitants in each.

Force employed at laboratory (Bussey Institute): —	
Pathologist,	1
Assistants,	3
	4

UNDER THE PROVISIONS OF CHAPTER 375, ACTS OF 1888.

Applications for advice from cities, towns and others: —	
Relating to water supply,	32
Relating to sewerage and drainage,	24
Relating to pollution of streams,	3
Total,	59

Number of samples of water examined chemically and microscopically at the Laboratory, Room 502, State House,	3,229
Number of samples of sewage and effluent from sewage purification works examined chemically at the Laboratory, Room 502, State House,	274
Number of samples of sewage and water examined chemically and bacterially at the Lawrence Experiment Station,	2,792
Number of samples of sand examined chemically and bacterially at the Lawrence Experiment Station,	340
Number of samples of sand examined mechanically at the Lawrence Experiment Station,	117
Additional samples examined bacterially at the Lawrence Experiment Station,	7,200
Total number of samples examined,	13,952

Force employed at central office: —		
Chief engineer,	1	
Assistant engineers,	4	
Stenographers and clerks,	2	
		7
At Laboratory, Room 502, State House: —		
Chemists,	1	
Assistant chemists,	4	
Biologist,	1	
		6
At Lawrence Experiment Station: —		
Chemists,	2	
Bacteriologists,	2	
Other assistants and laborers,	4	
		8
Total ordinary force employed under chapter 375, Acts of 1888,		21
Total ordinary force in all departments,		35

The number of applications for advice under the provisions of chapter 375, Acts of 1888, received since July, 1886, when the act relating to water supply and sewerage first went into operation, is as follows: —

1886,	8	1893,	51
1887,	22	1894,	53
1888,	28	1895,	52
1889,	38	1896,	65
1890,	23	1897,	59
1891,	53		
1892,	56	Total,	508

Recommendations.

The following recommendation was made to the Legislature at the beginning of the session of 1898: —

The Board recommends the continuance of its investigations now being carried on as authorized by the provisions of chapter 375 of the Acts of 1888. For this purpose, and to make the necessary investigations in order to advise cities, towns, corporations and individuals in regard to the best methods of assuring the purity of intended or existing water supplies and the best method of disposing of sewage, and to carry out the other provisions of chapter 375 of the Acts of 1888, the Board estimates that the sum of $30,000 will be required.

Expenditures.

The work of the Board is conducted under the provisions of several statutes, and for its different departments of work three appropriations are annually made, one for the general work of the Board, one for the inspection of food and drugs, and a third for carrying out the provisions of chapter 375 of the Acts of 1888, relating to the protection of the purity of inland waters. In addition to the foregoing, special appropriations have been made from time to time, as occasion has demanded, for the purpose of enabling the Board to conduct special lines of investigations.

The appropriations for the different departments of work in 1897 were as follows: —

For the general work of the Board,	$16,000
For food and drug inspection,	11,500
For carrying out the provisions of chapter 375, Acts of 1888,	30,000
Total,	$57,500

The expenditures in 1897 under the foregoing appropriations were as follows : —

General Expenditures Sept. 30, 1896, to Sept. 30, 1897.

Salaries,	$5,326 66	
Travelling expenses,	313 74	
Stationery,	345 27	
Printing,	1,280 00	
Books, subscription and binding,	227 27	
Advertising,	86 80	
Express,	145 48	
Extra services,	44 86	
Messenger services,	4 20	
Postage and postal order,	320 30	
Telephone and telegraph messages,	92 37	
Typewriting supplies,	9 85	
Zinc plates,	4 07	
Drafting diagrams,	25 50	
Special investigations,	451 30	
For revision of proof of manual of health laws,	45 00	
Printing manual of health laws,	686 75	
Sundry office supplies and incidental expenses,	28 86	
		$9,438 28

Expenditures at Bacteriological Laboratory.

Salaries,	$2,286 74	
Travelling expenses,	45 31	
Labor,	20 00	
Purchase of animals,	134 11	
Board of horses,	1,032 74	
Food for animals,	89 78	
Apparatus, chemicals and laboratory supplies,	840 69	
Express,	19 10	
Ice,	14 00	
Postage,	2 20	
Stationery,	12 05	
Rental of telephone,	156 00	
Sundry incidental expenses,	13 69	
		4,666 41
Total,		$14,104 69

Expenses under Chapter 375 of Acts of 1888 (Protection of Purity of Inland Waters) for Calendar Year, 1897.

Salaries, including wages of laborers at Lawrence Experiment Station,	$23,296 38
Apparatus and materials,	2,900 60
Rent of Lawrence Experiment Station,	150 00
Use of tools and office, Lawrence Experiment Station,	207 16

Travelling expenses,	$1,372 98
Express charges,	854 91
Freight and teaming,	45 63
Books, stationery and drawing materials,	528 36
Maps and blue prints,	137 75
Postage stamps,	47 81
Printing,	348 79
Messengers, telegrams and telephone messages,	20 44
Total,	$29,910 81

For Food and Drug Inspection for Year ending Sept. 30, 1897.

Salaries of analysts,	$4,839 00
Salaries of inspectors,	4,050 00
Travelling expenses and purchase of samples,	1,898 90
Apparatus and chemicals,	890 99
Books,	11 00
Index cards,	32 45
Express charges,	45 90
Extra services,	290 00
Sundry small supplies (bottles, towels, case for samples, etc.),	18 19
Total,	$12,076 43

HENRY P. WALCOTT,
HIRAM F. MILLS,
FRANK W. DRAPER,
GERARD C. TOBEY,
JAMES W. HULL,
CHARLES H. PORTER,
JULIAN A. MEAD,
State Board of Health.

WATER SUPPLY AND SEWERAGE.

ADVICE TO CITIES AND TOWNS.

ADVICE TO CITIES AND TOWNS.

Under the provisions of chapter 375 of the Acts of 1888, entitled "An Act to protect the purity of inland waters, and to require consultation with the State Board of Health regarding the establishment of systems of water supply, drainage and sewerage," the Board is required

"from time to time to consult with and advise the authorities of cities and towns, or with corporations, firms or individuals either already having or intending to introduce systems of water supply, drainage or sewerage, as to the most appropriate source of supply, the best practicable method of assuring the purity thereof or of disposing of their drainage or sewage, having regard to the present and prospective needs and interests of other cities, towns, corporations, firms or individuals which may be affected thereby. It shall also from time to time consult with and advise persons or corporations engaged or intending to engage in any manufacturing or other business, drainage or sewage from which may tend to cause the pollution of any inland water, as to the best practicable method of preventing such pollution by the interception, disposal or purification of such drainage or sewage; *provided*, that no person shall be compelled to bear the expense of such consultation or advice, or of experiments made for the purposes of this act. All such authorities, corporations, firms and individuals are hereby required to give notice to said Board of their intentions in the premises, and to submit for its advice outlines of their proposed plans or schemes in relation to water supply and disposal of drainage and sewage; and all petitions to the Legislature for authority to introduce a system of water supply, drainage or sewerage shall be accompanied by a copy of the recommendation and advice of the said Board thereon."

During the year 1897 the Board has given its advice to the following cities, towns, corporations and individuals who have applied for such advice under the provisions of the general act of 1888, or under special acts relating to water supply and sewerage.

Replies were made during the year to applications made from the following sources for advice relative to water supply: Brockton, Billerica, the Trustees of the Danvers Lunatic Hospital, Edgartown, Fairhaven, Fall River, Falmouth, Georgetown, Gloucester and East

Gloucester, Groton, Hudson (two replies), Huntington, Lee, the Massachusetts Hospital for Epileptics, the Reformatory Prison for Women, Medway, Milford, Natick, North Brookfield, Pepperell, Quincy, Springfield, Swampscott, Waltham, Wareham (together with Marion, Mattapoisett and Fairhaven on application of Joseph K. Nye), Watertown, Wellesley and Weston.

Replies were made during the year relative to sewerage and sewage disposal, in answer to applications from the following sources: Abington, Danvers, the Trustees of the Danvers Lunatic Hospital, Haverhill, Hull (Point Allerton), Leicester, Lexington, the Massachusetts Hospital for Consumptives, the Massachusetts Hospital for Epileptics, Mattapoisett, the Metropolitan Sewerage Commission (two replies), Mount Holyoke College (two replies), Natick (the Leonard Morse Hospital), North Adams, Quincy, Southbridge, Spencer, Taunton, the United States Arsenal at Watertown, Wareham (Onset Bay), Webster.

Replies were also made to the authorities of certain cities and towns, relative to the pollution of streams, as follows: The water commissioners of Needham, the board of health of New Bedford and the board of health of Whitman.

Water Supply.

The following is the substance of the action of the Board during the past year, in reply to applications for advice relative to water supply: —

Billerica. The water supply committee of Billerica applied to the Board, Feb. 4, 1897, for its advice relative to a proposed water supply for the town, to be taken from the ground near the west bank of the Concord River. The Board replied to this application as follows: —

March 4, 1897.

The State Board of Health received from you, on Feb. 4, 1897, an application for advice with reference to a proposed water supply for the town of Billerica, to be taken from the ground near the westerly bank of the Concord River, a short distance below the Corner Bridge, so called, and midway between the villages of Billerica and North Billerica. Accompanying the application was a report by your engineer, containing an account of the investigations made with reference to a source of water supply and a plan for supplying water from the proposed source to the town.

It is stated in this report that four tubular test walls were driven at the locality described, two of them to depths of 20 and 21 feet, respectively, and the others to depths of from 35 to 40 feet; and it appears that all of the wells penetrated sand or gravel strata, from which water could be pumped with considerable freedom with a hand pump. A sample of water collected from one of these wells having the least depth, and sent in by you for analysis, was found to be soft, practically colorless, and otherwise of good quality for the purposes of a public water supply. The sample probably represented water from the land side percolating toward the river; but if a large quantity of water should be pumped from the ground at this place, a portion of it might come by filtration through the ground from the river, and, while such water, if thoroughly purified by its passage through the ground, would not differ noticeably from water coming from the land side, it is desirable to have further analyses of this water made after a considerable quantity has been pumped from the ground, to learn whether it shows any tendency to deteriorate under such conditions.

The information contained in the report of your engineer as to the character of the material through which the wells were driven indicates that its quality is variable, ranging from fine sand to gravel; but the porous material, judging from these tests, extends to no great depth, and no water appears to have been obtained at a greater depth than 30 feet below the surface. It also appears that ledge was encountered in three of the wells, in one of them at a depth of a little over 20 feet beneath the surface. The tests are, on the whole, insufficient to show whether there is a layer of porous material beneath the surface in this locality of sufficient depth and extent to make it probable that enough water could be obtained from the ground here for the supply of the town.

Under the circumstances, the Board does not at present advise the construction of works for taking water from this source, but advises that you have further tests made by driving additional wells over a larger area, to determine more definitely the character of the ground beneath the surface. If, upon further examination, more favorable conditions are found, it is desirable that you cause a pumping test to be made by pumping continuously from a group of wells in this locality at a rate as great as would be necessary for the supply of a town of the size of Billerica, and for a sufficient time to determine whether this source can be depended upon to furnish enough water for the supply of the town at all times. It is desirable, also, in case a pumping test is made, that frequent analyses of the water be made during its progress, to obtain more definite information as to the probable quality of the water.

The Board will assist you in further investigations by making such analyses as may be necessary, and will, upon application, give you further advice in this matter when you have the results of additional investigations to present.

BROCKTON. An application was received Jan. 11, 1897, from the water commissioners of Brockton, for the advice of the Board with reference to enlarging the water supply of the city by taking the water of Silver Lake in the towns of Pembroke, Kingston and Plympton, and supplementing it, as occasion might demand, by diverting the water of Howard and Pine brooks into the lake and by taking the waters of Monponsett Pond in the towns of Hanson and Halifax. The Board replied to this application as follows: —

MARCH 4, 1897.

The State Board of Health received from you, on Jan. 11, 1897, an application for advice with reference to enlarging the water supply of the city of Brockton, accompanied by a report of the city engineer and superintendent of water works, containing an outline of a scheme for taking water from Silver Lake in the towns of Pembroke, Kingston and Plympton, to be supplemented, when occasion may require, by diverting the water of Howard and Pine brooks into the lake and by taking the waters of Monponsett Pond in the towns of Hanson and Halifax. In a subsequent communication you request the opinion of this Board as to the practicability and advisability of a ground-water supply for Brockton.

An examination of the records of consumption of water by the city in the last few years shows that the consumption is rapidly approaching the capacity of your present source in a dry year, and it is desirable to begin without delay the necessary investigations with a view to providing an ample supply of water for the future needs of the city.

The Board has caused an examination of Silver Lake to be made and samples of its water to be analyzed, and has also examined in a general way into the opportunities for supplementing this source from other sources in the vicinity.

The analyses of water from Silver Lake show that it is very soft, nearly colorless, and generally of excellent quality for the purposes of a public water supply. Analyses of samples of water collected from the bottom of the lake during the summer season were found to be of the same general character as those collected at the surface, and there was no evidence of the presence of decaying organic matter in the lower layers, such as is often found in the lower portions of deep ponds and reservoirs during the period of stagnation in summer.

The results of the microscopical examinations show that the total number of organisms present was small in all of the samples, but that some of the samples contained organisms of a kind which have been known to cause trouble from disagreeable tastes and odors in many ponds and reservoirs. The numbers of such organisms found were very small, however; and, while it is possible that at times the water will be affected by the presence

of larger numbers of such organisms, it does not seem probable, in view of the small amount of organic matter in the water, as indicated by the chemical analyses, that its quality will be seriously affected from this cause. There are several areas of swamp land of considerable size on the borders of the lake which should be drained to prevent injury to the quality of the water. The water-shed contains a very small population, but it is understood that the lake is used to a considerable extent as a summer resort, and it will be necessary to prevent danger of the pollution of the water from this cause.

Silver Lake alone will probably furnish from 50 to 75 per cent. more water in a series of very dry years than your present source would yield; but by the provisions of chapter 442 of the Acts of 1893 the town of Whitman has the right to a supply from this source, and in certain contingencies the small towns of Pembroke and Hanson may be supplied by the town of Whitman, so that the quantity of water available for Brockton would provide for only a limited number of years in the future.

From the information at present available it appears to be practicable to divert the waters of Howard and Pine brooks, at points where the area of their combined water-sheds will amount to about 4.2 square miles, into Silver Lake by gravity and at a small cost.

Analyses of the water of these brooks show that it is highly colored and contains a considerable amount of organic matter in solution, probably derived from contact of the water with vegetable matter in swamps. By diverting this water into the lake, however, an opportunity will be afforded for bleaching and sedimentation and other improvements which take place in a large lake where the water is stored for a period of many months, so that it is not likely that the water of these sources will have an unfavorable effect upon the quality of the water of the lake. Moreover, it may be possible to make a material improvement in the quality of this water by draining the swamps on the water-sheds of the brooks.

The quantity of water which Silver Lake would yield if these brooks should be diverted into it would be sufficient for the needs of Brockton and Whitman for about twenty years, should these places continue to grow at as rapid a rate as in the past, and making a liberal allowance for the increasing quantity of water used per inhabitant.

The second method suggested for augmenting the supply from Silver Lake is by utilizing the water of Monponsett Pond. The water-shed and storage capacity of this pond are so large that, taken in connection with Silver Lake and the water-sheds of Howard and Pine brooks, it would furnish a supply for Brockton and Whitman for a very long time in the future.

An examination of the water of the pond, however, shows that it is highly colored and contains a very large amount of organic matter, which would make it a decidedly objectionable source of water supply in its

present state. Its poor quality is due partly to the character of the pond, which appears to be a shallow basin with a muddy bottom containing a large amount of organic matter, and partly to the water-shed, which includes the area known as the Great Cedar Swamp. The conditions are such that it does not appear to be feasible to make any material improvement in the quality of water which this source will furnish; and in its present state it is not only unsuitable for domestic uses, but it is also probable that, if any considerable quantity of water containing so large an amount of organic matter should be discharged directly into Silver Lake, it would have an unfavorable effect upon the quality of the water of that source.

A general examination of the territory in the vicinity of Silver Lake indicates that there are other sources from which it appears to be practicable to obtain a large supplementary supply of water of better quality than that of Monponsett Pond, when the requirements of the city and town may make it necessary; and the Board would advise that the selection of a source be deferred until a thorough investigation of possible sources is made, which may indicate more clearly than the information at present available the most appropriate source from which to supplement the supply in the future.

From the investigation thus far made the Board concludes that Silver Lake is probably the most appropriate source of future water supply for Brockton; and, since the town of Whitman is in need of a better supply than it now has, it will probably be to the pecuniary advantage of both Whitman and Brockton, as already stated in a previous communication, to construct works jointly rather than to construct independent works.

The situation of Howard and Pine brooks is such that they would naturally be the first sources from which to supplement the yield of Silver Lake; and it is desirable that the right to use the water of these sources be secured in the beginning, since an auxiliary supply is likely to be needed in a few years after the water of Silver Lake shall have been introduced.

With regard to the practicability and advisability of a ground-water supply for Brockton the Board cannot give you a definite opinion, since it is not informed of any territory within a reasonable distance of the city from which there is reason to expect that a large supply of ground water may be obtained. In general, a good ground water is better for domestic uses than a surface water, on account of its attractive appearance and freedom from taste and odor. At the places where large ground-water supplies have been obtained for the supply of cities and towns in this State extensive collecting systems have usually been found necessary; and, since a ground water deteriorates rapidly upon exposure to light, in order to keep it in satisfactory condition it is essential that it be kept from exposure to light both at the source and in distributing reservoirs or tanks. With such a source it would be necessary, in designing your distributing reser-

voirs and tanks, that you make provision for covering them. If you have in view any source from which it is thought that it may be practicable to obtain a supply of ground water for the city, the Board will co-operate with you in making an examination, if you so request, and will advise you as to the practicability of developing it for the supply of the city.

Danvers Lunatic Hospital. The superintendent of the State Lunatic Hospital at Danvers applied to the Board, Nov. 4, 1897, for its advice with reference to a proposed water supply, to be taken from wells on the hospital grounds. The Board replied to this application as follows: —

Dec. 3, 1897.

The State Board of Health received from you, on Nov. 4, 1897, an application for advice with reference to a proposed water supply for the Danvers Insane Asylum, and has caused an examination of the locality from which the proposed supply is to be drawn to be made by one of its engineers, and a sample of the water of a tubular test well at this place to be analyzed.

The results of this analysis show that the water is quite hard, and has at some time been highly polluted by sewage, and it has not been completely purified in its subsequent passage through the ground. It is, therefore, an unsafe water for drinking or other domestic uses, and the Board does not advise the use of water from this source for the supply of the hospital.

Edgartown. The Edgartown Water Company applied to the Board, March 8, 1897, for its advice relative to a proposed water supply, to be taken from the ground at a place known as "Wintucket Bottom." The Board replied to this application as follows: —

March 17, 1897.

The State Board of Health received from you, on March 8, 1897, an application for advice with reference to a proposed water supply for the town of Edgartown, in which you state that you propose to take water from the neighborhood of "Wintucket Bottom," not far from the northerly end of Great or Herring Pond.

The Board has caused an examination of this locality to be made by its engineer, and has analyzed two samples of water, one collected by you in November, 1895, and another collected on March 10, 1897. The results of these analyses show that the water is of excellent quality in all respects for the purposes of a public water supply.

With regard to the quantity of water, the indications are favorable, both as regards the porosity of the soil and the freedom with which water could

be pumped from the test well, to obtaining a large yield of water from the ground at this place; and the Board would advise that the proposed source is a suitable one from which to take a water supply for the town of Edgartown.

It will be necessary, in case the supply is drawn from the ground, to provide for delivering the water to consumers without exposure to the light, either at the source or in a distributing reservoir or tank, in order to avoid danger of its deterioration from this cause.

FAIRHAVEN. Information was received by the Board of the occurrence of cases of lead poisoning, and the Board at once ordered an examination to be made with reference to the presence of lead in the water distributed in Fairhaven. The following statement was made to the board of health of Fairhaven: —

BOSTON, May 18, 1897.

The State Board of Health, having been informed by you of the existence of cases of lead poisoning in the town of Fairhaven, has caused samples of water to be collected from a number of houses in the town supplied with water from the public water works, and has had them analyzed to determine the quantity of lead present in the water.

The results of these analyses show, in all cases, the presence of lead-the amounts in many cases being so large as to be injurious to the health of those who may drink the water. Large quantities of lead were sometimes found in samples collected soon after the water had been drawn freely from the pipes.

There is no method known to the Board for readily removing lead from the water; and boiling the water, as in some processes of cooking, tends to concentrate a quantity of lead, and thereby renders it more harmful.

The Board would, therefore, advise that you warn the inhabitants of the danger of drinking water that has passed through lead pipes, and that provision be made for securing the removal of lead pipes wherever used for distributing or service pipes in connection with the public water supply.

On May 26, the board of health of Fairhaven published a notice warning the citizens with reference to the use of this water.

FALL RIVER. An application was received from the water board of Fall River, Aug. 25, 1896, for advice as to the best method of preventing the pollution of the public water supply. The Board replied to this application as follows: —

SEPT. 7, 1897.

The State Board of Health has considered your application for advice with reference to the danger of the pollution of North Watuppa Lake, the

source of water supply of the city of Fall River, by boating, bathing and excursion parties of various sorts, and has caused an examination of the lake and its surroundings to be made on several occasions by its engineers.

These examinations indicate that the lake and its shores are visited by considerable numbers of people at times in the summer season, who engage in boating and fishing upon the lake itself or in picnics upon its shores, and it is said that large numbers of people visit the lake in the winter time for skating.

There is no doubt that the unrestricted use of the lake in this way constitutes a danger to the purity of your water supply; and while at the present time the danger of serious contamination of the drinking water of the city from this cause is small, it should, nevertheless, be avoided. Trespassing upon the shores of the lake or upon the lake itself can be controlled by acquiring a strip of land bordering its shores; and it is understood that the city is now acquiring land about the lake, under authority granted by the Legislature. Bathing in ponds used as sources of water supply is already prohibited by statute. While it would seem to be no great hardship if all persons were prevented from using the lake at any time as a place of resort, since there are other waters in the vicinity which may be so used, it might, nevertheless, be practicable, with suitable restrictions and supervision, to allow a limited number of people to visit the lake for fishing or boating in the day time, as is done in similar cases by other cities of the State.

The Board would call attention, in this connection, to two other possible sources of contamination of your water supply.

There is already a considerable number of dwelling-houses within the water-shed of the lake, which lies close to the densely populated portion of the city; and, as no means are provided for removing the sewage from these houses to some place of disposal outside the water-shed, some of it probably finds its way, directly or indirectly, into the lake. While the pollution of the lake from this cause is probably slight at the present time, it is likely to increase rapidly should the population within the water-shed increase materially in the future, as it seems likely to do, owing to the proximity of the city.

An examination of the South Lake indicates that it may receive at times a considerable quantity of sewage, and it appears to be possible, under present conditions, for water from the South Lake to flow into the North Lake at a time when no water is being drawn by the mills on the Quequechan River, and it is desirable that some provision be made for preventing water from the South Lake from flowing into the North Lake at any time.

FALMOUTH. An application was received Nov. 8, 1897, from John S. Bleakie and others for advice with reference to a proposed water

supply for the villages of Falmouth and Woods Hole, to be taken from Long Pond in Falmouth. The Board replied to this application as follows: —

DEC. 3, 1897.

The State Board of Health has considered your application with reference to a proposed water supply for the villages of Falmouth and Woods Hole in the town of Falmouth, to be taken from Long Pond in that town, and has caused an examination of the proposed source of supply to be made by its engineer and samples of the water to be analyzed.

The area of the pond and its water-shed are such that it will furnish a much larger quantity of water than is likely to be needed for the supply of Falmouth.

Chemical examinations of samples of water from the pond show that it is soft and nearly colorless, and the indications are that its quality would generally be excellent for the purposes of a public water supply. The microscopical examinations, however, show the presence, in small numbers, of organisms of a kind which have been known to cause disagreeable tastes and odors in other ponds and reservoirs, and it is possible that the water of this pond is subject, in common with many ponds, at occasional periods to a disagreeable taste and odor.

An examination of the water of Grew's Pond, lying just south of Long Pond, shows that the water is of much less satisfactory quality than that of Long Pond.

A good ground water would be more satisfactory as a source of water supply than the water of Long Pond, on account of its freedom at all times from taste and odor. The shores of the pond, particularly about the southerly end, appear to be of a gravelly nature, and it is possible that a sufficient supply of water for the town could be obtained from the ground in this vicinity.

In view of the circumstances, the Board would advise that investigations be made to determine whether it is practicable to obtain a sufficient supply of good ground water for the town before constructing works to draw a supply directly from Long Pond.

Should you decide to make further investigations with a view to obtaining a ground-water supply, the Board will, if you so request, assist you by making analyses of samples of water, and will give you further advice in the matter when you have the results of further investigations to present.

GEORGETOWN. The selectmen of Georgetown applied to the Board, April 26, 1897, for its advice relative to a proposed water supply for the town, to be taken either from Rock Pond or from Pentucket Pond as a public water supply for the town. The Board replied to this application as follows: —

AUG. 5, 1897.

The State Board of Health has considered your application with reference to a proposed water supply for the town of Georgetown, in which you state that your plan is, in general, to use the water of Rock Pond or of Pentucket Pond as your source of supply, and has caused an examination of these ponds and their surroundings to be made by its engineer and samples of the water to be analyzed.

Either of these ponds is capable of supplying a much larger population than is found at present in the town of Georgetown, but chemical examinations show that the water is highly colored and contains a large amount of organic matter, which will make the water objectionable for drinking and other domestic uses. The Board, therefore, does not advise the use of water from either of these ponds for the supply of Georgetown, but advises that you investigate other available sources, to ascertain whether a better one cannot be found.

In connection with the investigation of Rock and Pentucket ponds, the Board caused analyses to be made of the water of Bald Pate Pond, so called, in the southerly portion of the town. These analyses show that the water of this pond is much better than any of the others, but it has, nevertheless, considerable color, and further examinations are necessary in order to determine the probable quality of the water.

In general, a supply of water drawn from the ground is much to be preferred to a supply taken from a surface source, because good ground water is clear, colorless and free from unpleasant taste or odor, and, if taken from unpolluted territory, may be nearly as soft as a surface water; and the Board would advise that, in making further investigations relative to a water supply, you determine whether there is any territory in the vicinity of the town from which a sufficient supply of ground water is likely to be obtained. If such a locality is found, tests should be made to determine the probable quantity and quality of water obtainable.

It is also suggested that you have samples of water from Bald Pate Pond collected and analyzed from time to time.

The Board will assist you in these investigations by making analyses of samples of water, and will, upon application, advise you further in this matter when you have the results of further investigations to present.

GLOUCESTER. The board of health of Gloucester applied to the State Board of Health, Dec. 14, 1896, requesting an examination of the quality of the water supplied to the city, including an examination of the water in the reservoir at Bond's Hill. The Board replied to this application as follows: —

MARCH 17, 1897.

The State Board of Health received from you, on Dec. 14, 1896, a communication requesting a careful examination of the quality of the water

supplied to the inhabitants of Gloucester from the Gloucester water works. Subsequently, in response to a request of the Board for information as to the prevalence in Gloucester of diseases which might be attributable to the pollution of the water, the Board received statements as to the number of cases of typhoid fever in the city, showing that 41 cases of this disease had occurred during the year 1896, 12 occurring in each of the months of September and October, 6 in the month of November, 2 each in the months of January, June, August and December, and 1 in each of the months of March, April and July.

It appears from the record of deaths, as returned to the Secretary of the Commonwealth, that there were 10 deaths from typhoid fever in Gloucester in the year 1896, or twice as many as the highest number occurring in any year during the previous five years, making the death rate from typhoid fever in 1896 3.5 per 10,000 living. While this death rate is but little if any larger than that of many cities of the State, it is a little greater than the average death rate from this cause in all of the cities; and, while this rate does not indicate a very serious epidemic in Gloucester during 1896, it nevertheless shows that the disease was considerably more prevalent than in the previous five years.

It appears from the first annual report of the water commissioners that the water used for the supply of the city during the year 1896 was drawn from Wallace Pond during the first half of the year or until July 1, with the exception of seven days in the months of April, May and June, when water was drawn from Dike's Meadow reservoir. From July 1 to December 1 the supply was drawn exclusively from Dike's Meadow reservoir; and, from the statement of the number of cases of typhoid fever occurring between Jan. 1 and Dec. 1, 1896, it appears that 33 out of a total of 39 occurred during the period when water was being used from this reservoir.

The Board is informed that the water-shed of this reservoir contains no human habitation, and the water does not appear to be exposed to sewage pollution from any source at the present time. An examination of the Bond's Hill distributing reservoir shows no change in the conditions affecting this reservoir since the last examination by the Board was made in 1895, and in this case also there is no reason for thinking that the water has been polluted by sewage, since the reservoir is situated in an uninhabited region. Moreover, the chemical analyses of the water of these reservoirs made recently do not show that any material change has taken place in the character of the water as compared with the analyses of previous years. Under the circumstances, there appears to be no reason, in the opinion of the Board, for attributing the prevalence of typhoid fever in the latter part of 1896 to the water supplied to the city from the Gloucester water works.

The water-shed of Wallace Pond is free from human habitations, but there is a picnic ground at its lower end which is said to be used to a con-

siderable extent in the summer season; and it is very desirable, in order to avoid danger of the pollution of the water, that the use of territory in the vicinity of your sources of water supply for such purposes should be prevented.

The Board would also repeat the suggestion made in previous replies, that the water supply of Gloucester could undoubtedly be improved in appearance and in other respects by the removal of stumps, soil and vegetable matter from the bottom and sides of the reservoirs.

GLOUCESTER. Information was received from the board of health of Gloucester that the water supply furnished to fishing vessels by Adolph Voss of East Gloucester appeared to be derived from objectionable sources. The Board made an examination of the territory from which this water was derived and the place in which it was stored. The walled cellar of a large wooden building constituted the reservoir, and this was subject to pollution from an adjoining stable-yard, and other objectionable sources along the brook which supplied the reservoir. Chemical analysis of the water also gave evidence of serious pollution.

The Board, therefore, sent a communication to the board of health of Gloucester, June 4, 1897, informing them that the analysis and inspection showed "that this source of water supply is very seriously polluted and is a possible source of disease. The Board, therefore, recommends that your board take prompt action in preventing its further use, either for drinking, for culinary or domestic uses."

This recommendation was complied with by the board of health of Gloucester.

GROTON. The Groton Water Company applied to the Board, March 8, 1897, for its advice relative to a proposed water supply to be taken from springs near Baddacook Pond, and from the pond itself when the springs were found to be insufficient. The Board replied to this application as follows: —

APRIL 21, 1897.

The State Board of Health received from you, on March 8, 1897, an application for advice with reference to a proposed source of water supply for the town of Groton, to be taken from springs in the vicinity of Shattuck Meadow, so called, about 1,600 feet from the westerly shore of Baddacook Pond, and to be supplemented by taking water directly from Baddacook Pond, in case the yield of the springs should prove insufficient for the supply of the town.

Subsequently plans were received showing a well in the Shattuck

Meadow, a pipe about 1,600 feet in length leading from the well to a proposed pumping station on the westerly shore of Baddacook Pond, a line of force main from the pumping station to an open distributing reservoir to be located on Gibbet Hill, and a system of distributing pipes in the town.

Since the application was made, you have made tests of the ground by means of tubular wells at three places within the water-shed of Baddacook Pond; one at the proposed location of the well in the Shattuck Meadow; another in the vicinity of the proposed pumping station, on the westerly side of the pond; and the third on the south-westerly side of the pond, at a place known as the "sandy shore." The results of the tests made at the first two places were unfavorable and no water was obtained from the wells, but the test wells on the south-westerly side of the pond penetrated a stratum of coarse gravel from which water could be pumped freely with a hand pump.

Samples of water from three test wells at this place have been analyzed by the Board, and the results show that the water is very soft, the hardness being much less than that of any other source that has been examined in the vicinity of Groton, and in other respects also the water is of excellent quality for the purposes of a public water supply.

With regard to the quantity of water that may be obtained from this source, a definite estimate cannot be made with present information; but, judging from the character of the surface of the ground in the vicinity of the pond, which is favorable to the absorption of a large portion of the water falling upon it, the porosity of the soil, as indicated by the material taken from the test wells, and the freedom with which water could be pumped from the wells, it may be said that the conditions are favorable to obtaining a large yield of water from the ground at this place. Moreover, if the ground water should be lowered by pumping from a well or wells here, it is probable that the supply would be augmented by the filtration of water from the pond through the ground and into the wells. Water derived by filtration from the pond in this way would probably not differ materially in quality from water derived from the land side.

In view of all the circumstances, the Board is of the opinion that a supply from the ground in the vicinity of the test wells on the south-westerly shore of Baddacook Pond will give more satisfactory results as to the quality of the water than any source examined in the vicinity of Groton, and the indications are favorable to obtaining a sufficient quantity of water at this place for the supply of the town. The Board would advise, however, that, before finally constructing works for taking a supply from this source, you make a more thorough examination, to determine the depth and extent of the porous material in this vicinity, and to determine, beyond a reasonable doubt, whether the quantity of water to be obtained from the ground here is likely to be sufficient for the supply of Groton at all times.

The plans of the proposed water works for Groton provide for an open distributing reservoir. Experience in this State with such reservoirs, when used for the storage of ground water, has shown in all cases that the water has greatly deteriorated, on account of the presence of large numbers of minute organisms which multiply rapidly in a ground water exposed to light, and impart to the water a disagreeable taste and odor. The Board would advise that the proposed distributing reservoir be covered so that the water will not be exposed to the light.

HUDSON. The water commissioners of Hudson applied to the Board, Jan. 27, 1897, for its advice relative to the question of enlarging and improving the water supply of the town. The Board replied to this application as follows: —

FEB. 17, 1897.

The State Board of Health received from you, on Jan. 27, 1897, an application for advice with reference to enlarging and improving the water supply of Hudson, in which you state that you propose, first, to build a new dam about 500 feet below the present dam at the outlet of Gates Pond, your present source of water supply, thereby making available an additional water-shed of about 26 acres; and, second, to divert into the upper end of Gates Pond the water of a small brook having a drainage area of about 123 acres at the proposed point of diversion. It is understood that you also propose, in constructing the new dam, to raise the water in Gates Pond about 2 feet above its present high-water level, thereby increasing somewhat the head under which water would be supplied to the town and increasing considerably the storage capacity of the pond.

It appears from your records of the height of water in Gates Pond that the pond has not overflowed for a period of seven years, several of them years of more than average rainfall; so that, while no records of consumption have been kept, the indications are that the quantity of water used by the town is already in excess of the yield of Gates Pond in a series of very dry years, such as have occurred in the past, and an additional supply is necessary.

The Board has carefully considered the proposed plan, and has caused a general examination of the pond and of the water-shed from which you propose to take an additional supply of water to be made by its engineer, and has caused samples of the water collected from the brook below Gates Pond, and of the brook which you propose to divert into the upper end of the pond, to be analyzed.

The quality of the water of the brook at the site of the proposed dam below Gates Pond is found from this examination to be excellent for water-supply purposes; but the increase in the area of water-shed and in the storage capacity of the pond that might be made available by constructing

the proposed dam, and the slight increase in the head under which water would be supplied to the town that would be obtained by raising the pond, would not warrant the outlay. It appears, however, that measurements of the quantity of water flowing in the stream just below the present dam indicate that the loss of water by leakage past the present dam is large, and might be much larger when the pond is full, or nearly so, and it further appears that you consider it necessary either to strengthen the present dam or to construct a new one; so that, under the circumstances, it is probably best to construct the new dam, as proposed, and if the extra area of pond that will be created by this dam is properly prepared for the storage of water by the removal of the soil and vegetable matter from the area flowed, the quality of the water is not likely to be affected unfavorably by the changes in its area and capacity.

The second portion of the proposed plan is to increase the capacity of Gates Pond by diverting into it the water of a small brook which drains a water-shed contiguous to that of the pond on the north. By this plan a large addition will be made to the capacity of your present works for supplying the town with water; but it is said that this brook becomes dry in the summer season, and the conditions appear to be such that the yield to be obtained from its water-shed may be smaller in proportion to its area than that of the immediate water-shed of Gates Pond; and if the town should continue to grow at the same rate as it has in the past ten years, and if the quantity of water used per inhabitant increases as in most places, it is probable that a further additional supply would be needed in a few years.

The quality of the water of this brook is indicated by analyses of two samples collected on Feb. 10, 1897, at a time when there was a large flow in the brook from a recent rain and from melting snow. One of the samples, collected at the point at which it is proposed to divert the water, showed that the water has a very high color, and contains a very large amount of organic matter, as indicated by the albuminoid ammonia. The second sample was collected about 500 feet further up stream and just above a small tributary, the water of which had much less color. The main stream at this point had a higher color than at the proposed point of diversion, but the quantity of albuminoid ammonia was found to be the same.

It is difficult to judge from a single analysis what the quality of the water is likely to be at other seasons of the year; but, so far as can be judged, these samples may be a fair representation of the average quality of water that this brook will furnish, since they were collected in the period of the year when the highest flows may be expected, and when the brook would contribute to the pond the bulk of the water that it might be expected to furnish in a year. If the single set of analyses thus far made is fairly representative of the average quality of water that this brook will furnish,

the Board is of the opinion that the diversion of this brook into Gates Pond may have unfavorable effect upon the quality of the water of the pond.

Examinations of the water of Gates Pond have been made from time to time by the Board for many years, and the results have shown that the water is soft, nearly colorless, and generally of good quality for the purposes of a public water supply; but the water has at times been affected by a disagreeable taste and odor, caused by the presence of considerable numbers of minute organisms. So far as observations of the Board have shown, serious trouble from this cause has occurred in only one year in the period of eight years covered by the examinations; but the discharge into the pond of a water containing so large an amount of organic matter as that found in the water of the brook in question would be liable to produce conditions under which microscopic organisms might thrive in much greater abundance than at present; and, in view of all the circumstances, the Board does not at present advise the enlargement of your supply by the diversion of the water of this brook into the pond, but would advise that you have frequent chemical analyses of the water made during the next few months, and, if these examinations indicate that the water is likely to be of a similar character to what it was found to be by the recent analyses, that you make further investigation with a view to supplementing the supply from some other source.

The Board will co-operate with you by causing the necessary analyses to be made, and will, upon application, advise you further with reference to increasing your water supply, when the results of further investigations are available.

From the examinations of the engineer of the Board it appears that there is a dwelling-house with out-houses located close to the shore of Gates Pond, not far from the gate-house, from the vicinity of which drainage must enter the pond; and the analysis of a sample of water collected through a hole in the ice close to the shore of the pond and in the vicinity of this house, indicated that the water was to some extent polluted by sewage. It appears, also, that there are several summer cottages along the shore of the pond, and that the pond is used as a pleasure resort in the summer season. These conditions are a serious menace to the health of those drinking the water, and the Board would advise that you proceed without delay to remove all danger of pollution of the water of Gates Pond by preventing the general use of the pond as a pleasure resort, and removing the houses on its shore to some place where the drainage from them will not pass into the pond.

The water commissioners of Hudson again applied to the Board, May 27, 1897, for its advice relative to the question of improving and enlarging the public water supply by certain measures indicated on a plan, being mainly the construction of a new dam below the

present dam at the outlet of Gates Pond, and the diversion of the water of another water-shed into the present supply. The Board replied to this application as follows: —

JULY 12, 1897.

The State Board of Health received from you, on May 27, an application with reference to enlarging and improving the water supply of Hudson, in which you state that, acting under the authority of chapter 242 of the Acts of 1897, you propose to take land around Gates Pond, substantially as shown on a plan submitted with your application, entitled "Plan of land at Gates Pond, Berlin, to be taken for the Hudson water works, B. R. Felton, C.E., Boston, May, 1897," and to take all rights now held by any person or persons on land previously taken by the town of Hudson, said land being located between the land you now propose to take and the original boundary of the pond, as shown on the plan referred to above.

You also propose to construct a new dam below the present dam, at the outlet of Gates Pond, approximately as shown on another plan submitted with your application, which will collect leakage from the present dam and the flow from a small additional water-shed. The proposed dam is to be higher than the present dam, and will raise the water in the pond two feet above its present high-water level. The present dam is not to be removed, but between the two dams it is proposed to remove the soil from the area to be flowed where it is not too deep, and, where the depth is such as to make the removal of the soil very expensive, to cover it with gravel or sand.

Finally, you request the advice of the Board as to the advisability of further increasing your water supply by diverting into the pond the water of a water-shed lying contiguous to that of the pond on the north.

The Board has caused an examination of the locality to be made by its engineers, and, having carefully considered the plans submitted, concludes that it is necessary, in order to prevent the danger of pollution of the water supply of the town, that the town should acquire lands about the pond, including the buildings at present located near the shores, and rights of access to the pond for any purpose the use of which, as at present, is a menace to the purity of the water. The area of land to be taken about the pond, as shown upon the said plan submitted by you, appears to be a reasonable one for the purpose for which it is intended, and the Board recommends and approves the taking and holding in fee of lands about the pond, as proposed, together with all rights in or upon these lands, or connected therewith, and all rights and privileges of access by any person or persons to the pond over land now owned by the town on the shores of the pond, the enjoyment and exercise of which might pollute, or tend to pollute, the water.

Regarding the second portion of your proposed plan, the Board has already expressed the opinion that, since you consider it necessary either to strengthen the present dam or construct a new one, it is probably

best to construct a new dam. The extra area of pond that would be created by this dam at present consists in part of a wooded swamp, and your plan includes the preparation of the land for flowage by the removal of soil where not too deep, but in places where mud or vegetable matter is so deep as to make its removal very expensive you propose to cover it with gravel or sand. It is very desirable that all of the soil, mud and vegetable matter be removed from the entire area to be flowed, but if there are places where its depth is so great that its removal is impracticable it can probably be covered with sand or gravel as proposed, in such a manner as to prevent its presence having an injurious effect upon the quality of the water; but, in the absence of information as to the location, depth and character of such areas, more definite advice as to their treatment cannot be given.

The final portion of your proposed plan involves the enlargement of the capacity of the pond by discharging into it the water of a small brook near its northerly end, and you request the advice of the Board as to the advisability of using the water of this source.

Several chemical analyses of this water have been made within the last four months, and the results show that the water is highly colored, at least during the portion of the year when the flow of the stream is greatest, and contains a very large amount of organic matter; and the diversion of this brook into Gates Pond would be likely to have an unfavorable effect upon the quality of the water of the pond. The water-shed of the brook is free from pollution; and, if the quality of the water were suitable, this would be an economical source from which to supplement Gates Pond, since it appears to be the only source from which the pond can be supplemented without pumping. An examination of the water-shed of the brook shows that it contains a considerable area of swamp land in its upper portion, but below the swamp the brook has a rapid fall nearly to the point at which it is proposed to divert the water. It may be feasible, by constructing drains along the borders of the swamp on each side, to intercept the water flowing from the higher portions of the water-shed, and at the same time to drain the swamp and prevent the water standing thereon, and thus greatly improve the quality of the brook water.

In view of all the circumstances, the Board does not at present advise the use of water from this brook to supplement the supply of Gates Pond, but would advise that you cause an investigation to be made to determine the feasibility and probable cost of draining thoroughly the swamp upon the water-shed of the brook, so as to cause the water to flow off quickly, and prevent it from acquiring a high color and a large amount of organic matter from remaining for a considerable time in contact with the vegetable matter in the swamp.

The Board will give you further advice in this matter when you have the results of further investigations to present.

HUNTINGTON. The committee on water supply of the town of Huntington applied to the Board, Oct. 16, 1897, for its advice with reference to taking the water of certain brooks in that town as sources of water supply for the town. The Board replied to this application as follows: —

DEC. 2, 1897.

The State Board of Health received from you, October 16, an application for advice with reference to a proposed water supply for the town of Huntington, in which you state that the plan which now seems most expedient is to construct a dam on Taylor (or Roaring) Brook, just below the point where it is joined by Clark Brook, and to distribute the water from a small reservoir, which it is proposed to form at this point, to the town by gravity. It is also proposed to increase the supply from this source, if necessary, by diverting the water of Pond Brook, which flows from Norwich Pond, into the water-shed of Roaring Brook, at some point above the proposed dam. You also state that you are considering the feasibility of uniting Cold and Cook brooks, which are tributaries of the Westfield River on opposite sides just above the town, and supplying the town by gravity from these sources.

The Board has caused an examination of the sources mentioned in your application to be made by one of its engineers, and samples of the waters to be analyzed, and has also caused examinations to be made of the waters of Woodruff Brook and Gold-mine Brook, which are not far from the village.

Taylor or Roaring Brook, the first source mentioned in your application, would probably furnish a sufficient supply of water for Huntington, even in the drier portion of a dry season, if its flow is well maintained in summer, as is said to be the case. Analyses of samples of the water of the brook collected recently show that it is soft, nearly colorless, and naturally of excellent quality for the purposes of a public water supply; but an examination of the water-shed shows the presence of numerous dwelling-houses, much of the sewage from which must find its way directly or indirectly into the streams. Under these circumstances, the brook cannot be regarded as a safe source from which to take water directly for domestic purposes, as is proposed under the present conditions. The houses, moreover, are widely scattered, so that it does not seem practicable to prevent the danger of pollution of the brook by providing a means of removing the sewage from the water-shed.

An analysis of a sample of the water of Norwich Pond, collected on October 26, indicates that the water at that time was of satisfactory quality for the purposes of a public water supply; and this source does not appear to be exposed to serious danger of sewage pollution, though it is becoming to some extent a place of resort in the summer season. The source will

yield much more water than is likely to be needed by Huntington, but the cost of works for supplying the town from this pond would be large, on account of its distance from the village.

Cook Brook is a stream of somewhat smaller size than Taylor Brook, which enters the Westfield River from the north, about a mile above the town of Huntington; while Cold Brook is a much smaller stream, entering the Westfield River from the south, nearly opposite the mouth of Cook Brook. The water of Cook Brook is of about the same quality as that of Taylor Brook. Cook Brook alone might possibly furnish a sufficient supply for Huntington without storage, if its flow is well maintained in the drier portion of a dry season; but the use of this source is open to the same objection as that of Taylor Brook, on account of the presence of numerous scattered farm-houses upon the water-shed, by which the source is exposed to danger of sewage pollution. Cold Brook has so small a water-shed that of itself it would probably not furnish a sufficient supply for Huntington during the drier portion of the year. There are only three or possibly four dwelling-houses upon its water-shed, and the quality of the water is naturally good, though it has slightly more color than that of Cook or Taylor brooks. It would apparently not be expensive to prevent danger of pollution of the water from the few houses on the water-shed; but it would be necessary, in order to secure a sufficient supply from this source alone, to construct a storage reservoir upon it, and it does not seem to be practicable to construct a reservoir of sufficient size, owing to the character of the water-shed, which is very steep, though further investigations may show that it is feasible to construct a reservoir upon this brook.

The Board has also caused an examination to be made of Woodruff Brook, a tributary of the east branch of the Westfield River, which enters the stream a short distance below Norwich bridge, not far from the village. The water of this brook is of about the same quality as that of Cold Brook, and, owing to the very small population upon its water-shed, it would probably be practicable to prevent danger of pollution of the water by sewage at a reasonable cost. The brook would not yield sufficient water for the supply of the town at all seasons of the year without storage, but there are apparently one or two sites at which storage reservoirs might be constructed. This brook is nearer the town than the other sources mentioned, and, under the circumstances, the feasibility of obtaining a supply for Huntington from it seems worthy of a thorough investigation.

An examination was also made of Gold-mine Brook, a tributary of the west branch of the Westfield River, entering it about a mile up-stream from Cold Brook. The color of the water is somewhat greater than that of the other brooks and the water contains considerably more organic matter, probably due to contact with vegetable matter in swamps, so that its quality may be somewhat less satisfactory than that of the others. The water-shed is, however, nearly free from population, and the danger of

the pollution of the brook by sewage could probably be avoided without much difficulty. It is not feasible to tell, with present information, whether this source would furnish a sufficient supply for the town of Huntington at all seasons of the year without the use of a storage reservoir; but there appear to be opportunities for constructing a storage reservoir, if it should be found necessary. It is possible also that, by the use of Cold Brook in connection with Gold-mine Brook, a sufficient supply for the town would be obtained at all times without storage.

As a result of its investigations, the Board does not advise the use of Taylor or Cook brooks for the supply of the town, but concludes that it is advisable for the town, first, to make an investigation in the valley of Woodruff Brook, to determine whether this source can be developed by the construction of a storage reservoir so as to furnish a sufficient supply for the town, and that a careful estimate of the probable cost of works be prepared, including the probable cost of removing all the soil and vegetable matter from the site of any proposed reservoir or reservoirs, and the cost of removing any sources of sewage pollution that may be found to exist.

An investigation should also be made of the probable yield of Cold Brook and Gold-mine Brook, and an estimate made of the cost of works for supplying the town from either or both of these brooks, either with or without a storage reservoir, as may be found necessary.

Finally, it is desirable that further investigations be made of the cost of supplying the town from Norwich Pond, including the cost of a strip of land about the pond, if necessary to prevent access to it.

The Board would advise that these investigations be made under the direction of an engineer of experience in the design and construction of water works. The Board will assist you in these investigations by making such analyses of water as may be necessary, and will, upon application, give you further advice when you have the results of additional investigations to present.

Lee. The Berkshire Water Company, in the town of Lee, applied to the Board, March 4, 1897, for its advice relative to the enlargement of its water supply by taking water from Basin Pond Brook. The Board replied to this application as follows: —

March 9, 1897.

The State Board of Health received from you, on March 4, 1897, an application for advice with reference to a proposed water supply for the towns of Lee and Lenox, in which you state that you have petitioned the Legislature for the right to extend the pipes of the Lee Water Company into the town of Lenox (for the supply of the village of Lenox Dale), and that you desire to obtain the right to take water from Basin Pond Brook,

also known as Washington Mountain Brook, in the towns of Lee and Washington, as an additional source of water supply, since your present sources might not be sufficient if the proposed extension should be made.

No definite information is available as to the capacity of Codding Brook, your present source of supply, and no record is kept of the consumption of water by the town, but it is understood there has been a shortage of water in at least two summers during the last six years; and, while the capacity of the works has been increased by raising the dam of a storage reservoir located on one of the tributaries of Codding Brook, the indications are that the consumption of water in the town is at present nearly as great as, if not greater than, the capacity of your present source, and an additional supply is necessary if the works are to be further extended.

The proposed source of supply, Basin Pond Brook, has a very much larger water-shed than your present source, but no information is available as to its probable flow in the drier portion of the year. It is said, however, that the flow is well maintained in the summer season, and if this is the case, this brook, under present conditions, would probably furnish a large addition to your present supply.

A sample of the water collected from this brook has been analyzed, and the results show that the water has considerable color, and that it is soft and contains a smaller amount of organic matter than the water of your present source. The amount of chlorine present in this sample was somewhat greater than is usually found in unpolluted waters of this region, indicating possibly a slight pollution by sewage.

It is not feasible, at this season of the year, to make a satisfactory examination of the water-shed of this brook; but it appears, from an examination of the maps of the region, that there is a considerable number of dwelling-houses within the water-shed, and it is possible that the source is exposed to pollution by sewage from these houses. If a supply of water should be drawn from this source, it would probably be taken directly from the brook without passing through a large reservoir, and there would be great danger that any pollution that might enter the stream would be conveyed directly into the distributing system of the towns. If, however, effectual means are taken to exclude sewage from the brook and its tributaries, this brook would, in the opinion of the Board, be a suitable source from which to take water for the supply of Lee and the village of Lenox Dale.

In a reply of the Board to the Lenox Water Company, dated Sept. 11, 1889, reference was made to the use of Basin Pond Brook for the supply of the town of Lenox, and a copy of that reply is enclosed herewith.

Massachusetts Hospital for Epileptics (at Monson). The trustees of this institution applied to the Board, Nov. 30, 1896, for

advice in regard to a proposed water supply for the institution, to be taken from the ground at the foot of the hill upon which the hospital stands. The Board replied to this application as follows: —

Feb. 5, 1897.

The State Board of Health has carefully considered your application for advice with reference to a proposed additional water supply for the Hospital for Epileptics, to be taken from the ground between the foot of the hill on which the hospital buildings are situated and the Quaboag River, and has caused the locality to be examined by one of its engineers, and samples of water sent in by you from test wells at the location of the proposed source of supply to be analyzed.

These tests were favorable both as regards the character of the material found beneath the surface and the freedom with which water could be drawn from some of the test wells, to obtaining a considerable quantity of water from the ground at this place, and water of some of the wells was found, upon analysis, to be of good quality; but the analysis of a sample from the well from which water could apparently be obtained with the most freedom showed the presence of a very large amount of iron, which would give the water a turbid appearance, and make it very objectionable for laundry and many other uses; and the water of another well was affected by its nearness to territory which has been used as a place of sewage disposal.

In view of these conditions, the Board would advise that you continue your investigations, to see whether it may not be practicable to obtain a sufficient supply of good ground water from some suitable source.

It is understood that your present sources of supply will furnish a sufficient quantity of water for the hospital during the greater portion of the year, and that the additional supply is required for use only during the drier portion of the year. An examination of the water-shed of your west reservoir shows that the water is exposed to serious pollution from farm buildings situated directly on the brook, a short distance above the reservoir. The quantity that the south reservoir will furnish is very small, and it appears that this reservoir is kept in reserve for fire protection. The remaining source, known as the ice pond, is also objectionable, on account of the population on its water-shed.

If the west reservoir and the ice pond are to be retained as sources of supply, provision should be made to prevent their pollution by sewage or other animal matter; and, in view of the probable cost of this work and the inferior quality of the water as compared with a good ground-water supply, it may be more economical to secure at once a new supply, sufficient for all seasons of the year, and avoid the use of the present sources.

The Board would also suggest that in making further investigations you take into consideration the feasibility and probable cost of obtaining a

supply from the town of Monson, within the limits of which the hospital is situated. This town is provided with an ample supply of ground water of excellent quality.

MASSACHUSETTS REFORMATORY PRISON FOR WOMEN (Sherborn). The superintendent of this institution applied to the Board, Sept. 30, 1897, stating a belief that the "supply of drinking water is not as pure as it should be," and at the same time requesting that an analysis of the water should be made. The Board replied to this application as follows: —

DEC. 3, 1897.

The State Board of Health has considered your application for advice with reference to the quality of the water supply of the Reformatory Prison for Women, which is drawn from Waushakum Pond, situated in Framingham and Ashland, and has caused an examination of the source of supply to be made by one of its engineers and samples of the water to be analyzed.

The chemical analyses indicate that the water in its present state is in general a fairly good water for domestic uses; but the quantity of chlorine present is somewhat above the normal for this region, indicating a small amount of pollution by sewage. The examination of the water-shed shows that there is a considerable population upon it, and the growing village of South Framingham is encroaching upon its north-easterly side, though a portion of the houses situated within the water-shed are connected with Framingham sewers. It also appears that the pond is a place of resort for picnics, and that sometimes large numbers of people visit it in the summer season. The pond is, therefore, exposed to considerable danger of pollution by sewage; but under the provisions of certain acts of the Legislature the prison commissioners have the authority to take steps to protect the water of the pond from pollution, and to appoint a watchman for the purpose, who shall have the powers of the district police. There is no doubt that a considerable protection is afforded in this way; but it is not practicable to prevent people from resorting to the pond in large and increasing numbers in the summer season, unless control of the shores is obtained so as to prevent access to the pond. The population living upon the water-shed is likely to increase in the future, owing to the nearness of the large and growing village of South Framingham, and there will be increasing difficulty in preventing the pollution of the pond from this population.

Under the circumstances, it is impracticable to prevent the danger of pollution of the pond except at a considerable expense, and it would probably be cheaper to obtain water in the future from another source, if a suitable one can be found within a reasonable distance of the prison.

It may be feasible to obtain ground water from the valley of one of the brooks in the vicinity of the prison by means of wells or other similar

works, and it is possible that sufficient water could be obtained at such an elevation that it would flow to the present pump well so that no material alteration in the works would be needed.

The Board would, therefore, advise that you have an investigation made to determine whether it is practicable to obtain a sufficient supply of good ground water in the vicinity of the prison.

Medway. The Medway Water Company applied to the Board, Sept. 23, 1896, for additional advice in regard to a proposed water supply for Medway, to be taken from the ground at the east end of Medway village, near Charles River. The Board replied to this application as follows: —

March 17, 1897.

The State Board of Health received from you, on Sept. 23, 1896, an application for further advice with reference to taking water for the supply of the town of Medway from the ground on the southerly side of Charles River, at the easterly end of Medway village. Your investigations in this region, previous to the time the last reply of the Board was made, had included tests of the ground by means of tubular wells on the northerly side of the river, in the vicinity of the corner of Walker and Village streets, where the tests were unfavorable to obtaining a supply of good water; and you subsequently made further tests, by means of a second group of wells on the southerly side of the river and about 500 feet further down stream, at the place to which you refer in your present application. Regarding this source the Board advised you as follows: —

The Board has caused an examination of this locality also to be made, and has found that the conditions, as regards the porosity of the soil, are favorable to obtaining water freely from wells here, and the territory on both sides of the river appears to be of a porous character, judging from surface indications; but with the information at present available it is not feasible to tell whether or not a sufficient supply of water for the town can be obtained from the ground in this vicinity.

Samples of water have been collected from each of the three test wells on two occasions, and the results show in general that the water has at some time been polluted but subsequently purified by its passage through the ground. The quantity of iron in all of the samples was so small as not to affect the quality of the water; but there was a marked increase in the quantity of iron found in the second set of samples, which were collected after pumping for about ten hours daily for several days with a hand pump. The quality of the water in other respects improved somewhat with pumping.

The changes that took place in the character of the water while pumping only a comparatively small amount from the wells make it impossible to predict what the probable character of the water would be, after pumping continuously for a long time a quantity such as would be needed for the supply of Medway. The location of the proposed wells, in the vicinity of Charles River, a stream which

receives considerable sewage pollution from the factories and villages along its banks above this point, makes it essential that any water that may enter the wells from the river shall be thoroughly purified by filtration for a long distance through the ground.

In view of all the circumstances, the Board does not advise the construction of works for taking a supply of water from the ground in the vicinity of the present test wells until you have made further tests by driving wells and pumping from them continuously, at as great a rate, at least, as would be necessary for the supply of a town like Medway, and for a sufficient time to determine whether this source can be depended upon to furnish water of satisfactory quality for drinking purposes, and in sufficient quantity for the supply of the town.

It is very desirable, in putting in additional wells, that they be placed at a much greater distance from the river than the present test wells.

The Board will, upon application, give you further advice in this matter when you have the results of further investigations to present.

In your present application you state that, in accordance with the reply of the Board, a pumping test had been made and a new well driven in this locality. You also state: —

Some eight wells have been driven in this vicinity since the first application, of which four lie on the north and four on the south bank of the river. Analyses have been made from seven of these wells by your Board, and from some of them analyses have been made two or three times. It is the purpose of the company to obtain a supply for the town from the subsoil in the vicinity of these wells on the south bank of the stream, either by driven wells or a large dug well or gallery, and to force the water through proper pipes to a storage stand-pipe in the village.

In a consideration of this source by your Board, it should be borne in mind that the company are limited by statutory requirements to the town of Medway, and the natural conditions are such that there are but two possible sources to be considered. The first is Charles River and the second a stream called Chicken Brook. Charles River is too polluted with manufacturing wastes to be considered as a public water supply at this point.

Tests for ground water have been made throughout the valley in Medway. With the exception of the location now presented to your Board, there is no point upon the stream known to the company (and they have made considerable examination and have put in a number of test wells elsewhere) which will yield water in any quantity sufficient for consideration. The soil encountered in other places is clay and hardpan, and no results can be obtained.

Chicken Brook receives the direct drainage of a large portion of West Medway. Above the village proper there exists an opportunity for a small, shallow storage basin, which might be improved at a very considerable outlay. About five acres of shallow flowage would thus be obtained, the depth of water being ten feet at the maximum point. The stream above drains woodland, swamp and highly cultivated fields in about equal proportions. During the drier seasons of the year, the brook has been known to be dry above this storage basin. Under the present information the company thinks that the problem of obtaining a supply from Chicken Brook would entail large expenditures for construction, buying the mill privileges, etc., and the question of sufficiency of supply might be a serious problem

in dry seasons owing to the small storage available. The quality of the water in the storage basin referred to would in dry times be, undoubtedly, not of the best. To obtain a supply from this source by filtration would improve the quality but in no way increase the amount.

The company submits for your special consideration the source near Charles River, and asks that the conditions with regard to difficulty of obtaining another source be taken into account. The company has before received a communication from your Board, dated March 1, 1892, which touches upon the Chicken Brook. In this it is suggested that a ground-water supply be sought.

It appears from information furnished by you that the pumping test referred to was made by pumping from one of the wells originally driven on the southerly side of Charles River at the easterly end of Medway village, at a rate of about 100,000 gallons per day for a period of four days ending Sept. 4, 1896, and the freedom with which water could be pumped from the well is favorable to obtaining water from the ground at this place in considerable quantity.

No examination of the water was made at the beginning of this test, because the Board was not informed that the test had been begun; but a sample was collected just before the end of the test, and has been analyzed by the Board, the results showing that the quantity of iron present in this sample was insignificant, and that the water in its present state. while somewhat hard, is otherwise of fairly good quality for water-supply purposes. This analysis, like the former analyses of samples of water collected from wells in this vicinity, shows that the water has at some time been polluted by sewage, and subsequently purified by its passage through the ground; but, comparing the last analysis with those made previously, it is found that the quality of the water has deteriorated, and the evidences of previous sewage pollution are more marked.

The changes that have taken place in the quality of this water while pumping the comparatively small amount that has thus far been drawn from the wells make it impossible to predict definitely what the character of this water might be, after pumping continuously for a long time a quantity such as would be needed for the supply of Medway, but the indications are that the water would still further deteriorate and become harder than at present. Moreover, the situation of the wells with respect to the river is such that, if a large quantity of water should be pumped from the ground at this place, a portion of it would probably come by filtration through the ground from the river; and while such water, if thoroughly purified by its passage through the ground, would probably be of satisfactory quality, it might, if not perfectly purified, be dangerous to the health of those using it, on account of the polluted condition of the river water.

Experience with many ground-water supplies in the State situated on the banks of streams or ponds has shown that in some cases the waters have remained unchanged after many years of continuous use, while in other

cases the waters have deteriorated with long-continued pumping, owing to the water from the neighboring pond or stream passing into the wells without being perfectly purified in its passage through the ground. The danger of imperfectly purified water entering the wells now under consideration from the Charles River might be lessened by locating the wells at a greater distance from the river.

Considering the desirability of obtaining a source of supply in the beginning that is of excellent quality and free from any danger of sewage pollution, the Board does not, with its present information, advise the taking of a supply of water for the town of Medway from this source.

It appears, from the statements accompanying your application, as given above, that from the results of your investigations you consider the proposed source the most favorable one, all things considered, from which it is practicable to obtain a water supply for the town of Medway, and that by the terms of your charter you are limited in the selection of a source of water supply to sources within the town. The thickly populated portion of the town of Medway is situated in the immediate vicinity of the Charles River, which forms its southerly boundary; and, while it is desirable that the town should be supplied with water from some source within its own limits, the conditions appear to be such that it may be practicable to obtain a more satisfactory supply outside of the limits of the town and yet within a reasonable distance of the thickly populated portion.

In view of all the circumstances, the Board would advise that you cause an investigation to be made to determine whether it is practicable to obtain, anywhere within a reasonable distance of the thickly settled portion of the town, a sufficient supply of good water from some more satisfactory source than that proposed in your application, since, if such a source can be found, it would probably be in the interests of all concerned that it be secured.

The Board will assist you in further investigation, if you desire, by making analyses of water, and will, upon application, give you further advice when you have the results of additional investigations to present.

MILFORD. Information was received from the Massachusetts General Hospital that a patient, a child about ten years old, was being treated there for lead poisoning, and that she was admitted to the Hospital from the town of Milford.

The Board then ordered an investigation to be made of the water supply of that town, with reference to the solvent effect of the water upon lead pipes. Samples were obtained from the house where this patient lived and from other houses in the town. It was found on analysis that the water "contained lead sufficient in quantity to be injurious to those who used the water for drinking," and therefore

the State Board promptly notified the board of health of Milford of this fact on Jan. 21, 1897, in order that they might "take such action in the matter as was found to be necessary."

Natick. The water commissioners of Natick applied to the Board, Aug. 16, 1897, for its advice relative to a proposed additional water supply to be taken from the ground on the east side of Lake Cochituate. The Board replied to this application as follows: —

Nov. 4, 1897.

The State Board of Health has considered your application for advice with reference to a proposed additional water supply for the town of Natick, to be taken from the ground on the easterly side of Lake Cochituate, and just south of the Worcester turnpike, and has caused an examination of the proposed source to be made by its engineer and samples of water from two test wells at this place to be analyzed.

It appears that the consumption of water by the town in 1896 was nearly as great as the probable capacity of the present source of supply in a series of dry years. Moreover, the consumption of water has been increasing rapidly in the last few years, and the recent introduction of a sewerage system will have a tendency to increase still further the use of water in the town, so that it is evident that an additional supply has become necessary.

The water-shed of Dug Pond, your present source of supply, contains a large population, located chiefly along its main feeder, and the pond is exposed to pollution, by sewage from this population. Moreover, the intake pipe of your water works is situated upon a narrow arm of the pond into which the main feeder flows. With these conditions, your present source is not a safe one for domestic uses; and the Board would advise that, in selecting another source of supply, you secure one that is capable of supplying the needs of the town for the present and for a reasonable time in the future, in order that the present source may be abandoned.

The test wells referred to in your application are located on a small peninsula, between the southern and middle basins of Lake Cochituate, which is surrounded on three sides by the lake, and the quantity of water obtainable from the ground here will probably depend largely upon the porosity of the soil and the quantity of water that will filter through the ground from the lake. The soil in this region, judging from surface indications and from the two test wells thus far driven, is coarse and porous, and it seems probable that water will filter freely through the ground from the lake, so that the indications are favorable for obtaining a large quantity of water from the ground at this place.

The quality of the water, as indicated by analyses of samples collected from the test wells, is excellent for the purposes of a public water supply;

but these samples probably represented water percolating through the ground toward the lake, and if a large quantity of water should be pumped from the ground at this place, a large proportion, as already indicated, is likely to come by filtration through the ground from the lake. It is not likely, however, that its quality will change materially from this cause, if the water is thoroughly filtered in its passage through the ground. It appears to be practicable to locate the works in such a way that water coming from the lake will have to pass for a distance of at least 300 feet through the ground; and experience in other places, where large quantities of water are obtained partly by filtration from neighboring bodies of surface water, would indicate that if the water is of good quality in the beginning it may remain so, at least for many years.

On the whole, the source appears to be a favorable one from which to obtain a large quantity of water from the ground, and the Board would advise that a test be made by pumping from a well or wells in this vicinity at a rate as great as would be necessary for the supply of Natick, and for a period of two or three weeks, and that observations be made, by means of test wells, of the variation in the level of the water in the ground, in order to determine the probability of obtaining a sufficient supply of good ground water for the town of Natick at this place.

The Board will assist you in these investigations by making the necessary analyses of samples of water, and will, upon application, advise you further in this matter when you have the results of further investigations to present.

The present works of the town of Natick include an open distributing reservoir. If a ground-water supply is introduced, it will be necessary either to cover this reservoir so as to exclude the light, or to provide a covered reservoir for general use in connection with the works. In the latter case, the new reservoir might be of small capacity, and the present reservoir be kept for use in emergencies.

North Brookfield. The board of health of North Brookfield applied to the State Board of Health, Dec. 1, 1897, requesting an examination of the public water supply of the town, and advice as to its quality for drinking and domestic use, at the same time asking whether it was necessary to boil the water before using it for drinking. The Board replied to this communication as follows: —

Jan. 6, 1898.

The Board has caused an examination of the sources of supply of the town to be made by one of its engineers, and has carefully considered the results of numerous analyses of samples of water sent in by the water works authorities once each month since the works were completed.

It appears that the supply is at present drawn from Doane Pond through a strainer or filter constructed in the pond in the form of a cylinder, with a well in the centre from which the supply of the town is directly drawn.

A comparison of the results of analyses of samples of water collected from the filtered-water well with those collected from the pond shows that the filter removes a small proportion of the organic matter, chiefly that which is in suspension in the form of microscopic organisms. The filtered water, nevertheless, has a high color and generally a strong vegetable odor. which is not driven off on heating the water. The water generally contains a large amount of organic matter, as indicated by the albuminoid ammonia, and the microscopical examinations show the presence at times of large numbers of microscopic organisms of kinds which impart to water a disagreeable taste and odor.

The water-shed of the pond contains a comparatively small number of inhabitants, and the pond does not appear to be exposed to serious danger of pollution by sewage. The presence of the large amount of organic matter found in this water affects its appearance and taste and odor rather than its healthfulness, so far as can be judged from our present information; and it does not appear to be necessary, in this case, to boil the water before drinking, nor is it likely that any material improvement in its quality would be effected by boiling.

A short time before the works were constructed, application was made by the town authorities to the State Board of Health for advice as to the proposed plan for supplying the town with water from this source; and a copy of the reply of the Board made at that time, and which was subsequently printed in the annual report of the State Board of Health for 1892, is enclosed herewith.

It will be seen that the Board advised at that time the cleaning of Doane Pond by removing from its bottom and sides the vegetable matter, which doubtless constitutes to a considerable extent the food for the organisms which thrive in this water, and that provision also be made for preventing shallow flowage; but from a recent examination of the pond it appears that it was not cleaned at the time the works were constructed, and it appears, moreover, that the water of North Pond, which also contains a large amount of vegetable matter, is drawn into Doane Pond at times, instead of being carried around it in a canal, as was first proposed.

The quality of the water can be improved by filtration through a properly constructed filter, or it can be improved by removing the soil, mud and vegetable matter completely from the bottom and sides of Doane Pond, and preventing the water of North Pond from entering it.

Pepperell. An application was received, Dec. 14, 1896, from the selectmen of Pepperell, for the advice of the Board in regard to a proposed water supply for Pepperell, the selectmen having already

examined certain localities by means of test wells, with unfavorable results. To this application the Board replied as follows: —

FEB. 5, 1897.

The State Board of Health received from you, on Dec. 14, 1896, an application for advice with reference to a proposed water supply for the town of Pepperell, in which you state that by the advice of the State Board of Health you have driven test wells in the valley of Unquetenassett Brook, near the Boston & Maine Railroad, with unfavorable results. You further state that you have made examinations of the ground near the mouth of Sucker Brook by means of wells, with the result that ledge is found at the depth of 8 or 9 feet beneath the surface, and you request the Board to make a further examination, and advise you as to the advisability of making further tests.

The Board has caused an examination to be made, by one of its engineers, of the localities where the test wells were driven, and of other localities which have been mentioned in connection with a proposed water supply for Pepperell, including the valley of Unquetenassett Brook. It appears, from information furnished by you, that the tests of the ground in the valley of this brook were limited to sinking three wells in a small area near the point where the brook is crossed by the Boston & Maine Railroad. The examinations made by the Board indicate that more favorable conditions for obtaining ground water, judging from surface indications, are found farther up stream. On the westerly side of the brook, between the place where the tests were made and the road from Pepperell to Dunstable, which crosses the valley about a mile and a half farther up stream, there is an extensive area of porous land, which is favorable, judging from surface indications, to the absorption of a large amount of water from the rainfall. Above the Dunstable road, also, the soil in the valley of the brook appears to be coarse and porous, especially on the westerly side nearly to the next road, which crosses the valley about a mile above.

In view of these conditions, the Board would advise that you continue the tests in this region by driving wells at intervals along the valley of the brook, beginning above your present test wells, and continuing, if necessary, to the next road crossing above the Dunstable road, to determine whether porous soil is found beneath the surface in this valley at any place from which water of good quality can be drawn with freedom from the ground. If favorable conditions are found at any place, further tests should be made to determine the probable quantity of water that can be obtained, and analyses of the water made to determine its suitability for domestic uses.

The Board will co-operate with you by making analyses of water, and will, upon application, advise you further when you have the results of additional investigations to present.

Judging from the information furnished by you as to the results of the tests made in the vicinity of the mouth of Sucker Brook, showing the presence of ledge within 8 or nine feet of the surface, it would be useless to attempt to obtain water from the ground at this place for the supply of the town.

QUINCY. An application was received from the water commissioners of Quincy, Feb. 9, 1897, for the advice of the Board relative to a proposed temporary water supply to be taken from Town Brook near the pumping station "during the months of July, August, September and October, or as soon as the water ceases to flow over the dam, until it is assured that the danger of a dry season is over." The Board replied to this application as follows: —

MARCH 17, 1897.

A comparison of the consumption of water in the last two or three years with the capacity of your present works shows that, should a dry season occur before the supply of the metropolitan district is available, the present supply would be inadequate for the needs of the city, and a temporary additional supply should be secured without delay.

The Board has caused an examination of Town Brook and its water-shed above your present pumping station to be made, and finds that there are more than 300 houses within the water-shed in the city of Quincy and the town of Braintree, most of which are within the portion of the water-shed which is tributary to the brook below the storage reservoir.

As there are no sewers to remove the sewage from these houses, much sewage necessarily finds its way directly or indirectly into the brook. Analyses of samples of water collected from the brook near the pumping station, and from a tributary flowing from the direction of Braintree, showed marked evidence of sewage pollution, notwithstanding the large quantity of water flowing at this season of the year.

With those conditions, the Board is of the opinion that the introduction of water from this brook into the distributing pipes would endanger the health of the people of the city, and advises that you avoid the use of water from this source.

In a previous application from the city of Quincy, relative to an additional water supply, it was proposed to increase the supply of the city by the construction of a new storage reservoir on a tributary of Town Brook north of the present reservoir, and to divert into the existing and proposed reservoirs the water of the Blue Hill River. In its reply to this application (dated Jan. 3, 1895), the Board, finding that it was for the interests of the city that it should form a part of the metropolitan water supply district, and construct works of a temporary nature, instead of permanent works, suggested two methods for temporarily increasing the supply, and the Board would again call attention to those suggestions, which were as follows: —

Two plans for temporarily increasing the supply are suggested The first proposes the utilization of the water which filters from the existing reservoir, and is wasted, and the water which flows down the small brook upon which the proposed reservoir is located. These waters could be diverted into a small open basin, to be dug some distance below the dam, and pumped from this basin back into the reservoir, from the time in the early summer when the reservoir stops overflowing until the season is so far advanced that it becomes evident that there will be no shortage of water during the year. This plan of pumping back into the reservoir, rather than directly into the pipe leading to the existing pumping station, is suggested because the water filtering past the dam of the reservoir contains so much iron that it would be objectionable if pumped directly to the city, and this iron would disappear by sedimentation if the water were pumped back into the reservoir at a point not too near the gate house.

The second plan proposes supplementing the present supply by taking water from the Blue Hill River, either by diverting the water by gravity through an open channel or by a pipe, — as proposed in the permanent plan for taking water from this river, — or by the erection of a temporary pumping station at the point where the river approaches nearest to the existing reservoir.

For such temporary works for taking water as here proposed it will probably be cheaper to lease land than to buy it, and to arrange with the mill owners upon the river for the temporary diversion of the water, rather than to make a permanent taking.

Of the two plans proposed, the first would be the cheaper one, and would probably supply sufficient water to prevent a shortage in a moderately dry year for the next three years, but might fail if an extremely dry year should occur within that time. The second plan has the advantage that it would furnish a more abundant and certain supply. If the first plan were adopted, and it should be found inadequate, it might still be feasible to resort to the second.

Other methods of obtaining a temporary additional supply may suggest themselves to you, such as, for instance, the purchase of water from the town of Braintree, if it should decide to increase its supply by taking water from Great Pond.

SPRINGFIELD. An application was received, June 22, 1896, from the water board of Springfield, requesting an examination by the State Board of Health of the waters of Loon and Five-mile ponds, with reference to their use as auxiliary sources of water supply for the city. It was also suggested that this examination should extend throughout the following summer, fall and winter. Advice was also asked as to the method of treatment of the water of the old Ludlow reservoir. The Board replied to this application as follows: —

MARCH 5, 1897.

The Board has caused an examination of the existing and the proposed sources of water supply to be made by its engineer, and samples of the water of Loon and Five-mile ponds, collected at frequent intervals during the last half of 1896, to be analyzed. The results of these analyses show

that the waters of these ponds are soft and nearly colorless, and generally good for the purposes of a public water supply. Microscopical examinations have shown the presence at times of organisms of a kind which have been known to cause disagreeable tastes and odors in the waters of ponds and reservoirs; but, while the quality of the water of these ponds may be unfavorably affected at times in this way, it does not seem likely, judging from the examinations thus far made, that the troubles from this cause would be long continued, and no trouble might be experienced for considerable periods of years.

The quantity of water which these sources would yield in connection with present sources cannot be estimated with accuracy from present information. The present canal system tributary to Ludlow basin drains an area of about 18.5 square miles, and, with the additional drainage area and storage that would be available, should the sources now proposed be used in connection with present works (excluding Ludlow reservoir), the yield might be in the vicinity of 5,500,000 gallons per day if the amount of water collected should be in proportion to the amount collected upon the Sudbury river water-shed. It is thought, however, that there is a large loss of water by leakage from the canals, which might greatly reduce the yield of the sources. On the other hand, the storage capacity of Five-mile and Loon ponds may be considerably in excess of the apparent capacity of these ponds, on account of their situation in the midst of a sandy plain, from which much water stored in the interstices of the soil might be contributed to the ponds if they should be drawn to a low level.

In the absence of definite information as to the yield of the water-sheds and consumption of water in the city, there is a doubt as to whether, if Five-mile and Loon ponds should be added to the present works (exclusive of Ludlow reservoir), the capacity would be sufficient for the city during the next two or three years, should a very dry season occur. Under the circumstances, the use of these ponds as permanent additional sources of supply is of doubtful economy, though it may be advantageous to use them as temporary sources should the necessity arise for emptying Ludlow reservoir.

The old Ludlow reservoir, if used in connection with the canal system tributary to the present Ludlow basin, is probably capable of furnishing a sufficient supply for the city for the next twenty or twenty-five years, should the growth of the city be about as rapid as may be expected from its growth up to the present time, and if the consumption of water does not exceed 100 gallons per inhabitant. The situation of Ludlow reservoir with reference to the present canal system and to the mains leading to the city, its elevation above the city, and its great storage capacity as compared with any pond or reservoir in this region, would combine to make it the most advantageous source of supply that could be used by Springfield under present conditions, were it not for the quality of its water, which is

extremely objectionable for drinking and many domestic purposes during the warmer portions of the year.

The cause of the enormous growths of organisms in Ludlow reservoir appears to be the presence at the bottom of the reservoir of an abundant food supply. The character of the bottom is described in considerable detail in the report of the Springfield Water Board for 1875, pages 41 and 42. It appears from this report that, of the area flowed by the reservoir, 281 acres were covered with wood in various stages of growth, a part of which was low, swampy land, the mud or peaty deposit ranging from 6 inches to 4 feet in depth. These peaty areas are not less than 12 feet below high-water mark, most of them as much as 16 feet. The stumps were cut low and all wood and brush was burned and the stumps were charred. Six and three-eighths acres of the most objectionable portion of the swamp were sanded over to the depth of nearly 1.5 feet. The shores to a depth of at least 12 feet are, as a rule, abrupt. A comparatively small area near the upper end of the reservoir is an exception to this rule, the water being quite shallow.

The quality of the water of this reservoir was found to be bad soon after its completion in 1875, the taste and odor being very objectionable. The water was examined weekly during the summers of 1876 and 1877 by Prof. William Ripley Nichols, who found a very large amount of vegetable matter in suspension, consisting largely of microscopic organisms. At the time the examinations of the State Board of Health were begun, in 1887, the water appeared to have the same general character as at the time it was examined by Professor Nichols, ten years earlier. The examinations of the State Board of Health showed no marked improvement in the character of the water up to 1892, when the water was drawn off from the reservoir, and an opportunity was afforded for determining the effect of allowing the reservoir to remain empty through the winter. In the latter part of the spring of 1893 the filling of the reservoir was begun again, but very little water was collected during this season. During the following winter and spring the reservoir was refilled nearly to high water, and its quality during this year appears to have been very much better than in any previous year. The examinations show that the quantity of organic matter in the water during the summer and fall seasons was not materially larger than in other portions of the year, and the number of organisms present was much smaller than in any previous year covered by the examinations. In 1895 the quality of the water remained about the same as in 1894 until the end of August, when the organic matter increased rapidly, and the quality of the water was very objectionable during the months of September, October and November. In 1896 the water began to be affected by larger growths of organisms early in the summer, and throughout the summer and fall the water appears to have been as bad as ever before.

In the cases of some reservoirs of this sort the water has shown improvement after a longer or shorter period of use, but in other cases no material improvement in the quality of the water has occurred after many years. In the case of Ludlow reservoir, with the exception of the years 1893 and 1894, there has been nothing in the examinations of the water, which have now covered a period of ten years, to indicate any diminution in the growth of organisms. The effect of allowing the reservoir to remain empty for one winter has already been indicated, the result being that after the reservoir was refilled, in the winter of 1893–94, there was no large growth of organisms during the year 1894, and the quality of the water was not seriously affected in this way during the greater portion of the next year; but at the end of the summer of that year (1895) the organisms reappeared in as great numbers as ever before, and during the whole of the summer and fall of the following year (1896) the water was apparently as bad as ever. Under the circumstances, there seems to be no reason to expect that any more permanent improvement would be obtained by again emptying the reservoir and allowing the bottom to be exposed to frosts during the winter.

There appear to be two ways in which the quality of the water of this reservoir can be greatly improved — one by removing all the soil, mud and organic matter from the bottom of the reservoir, and the other by the filtration of the water.

The experience with large reservoirs prepared for the storage of water by the removal of all the soil and organic matter from their bottoms has been very favorable. Reservoir No. 4 of the Boston water works was filled in 1886, and its water has always been comparatively free from growths of microscopical organisms, and there has been little or no evidence of the accumulation of the products of decomposition in its lower layers during the period of stagnation in summer, — a condition often found in deep ponds and reservoirs from which the soil and organic matter have not been removed. Reservoir No. 6 was completed at the end of 1893 and was filled in the spring of 1894. The analyses of its water show results similar to those found in the case of Reservoir No. 4. The satisfactory results obtained in these cases have led to the general practice of preparing reservoirs to be used for the storage of water in a thorough manner in the beginning.

The information furnished by emptying the Ludlow reservoir, and subsequently filling it again with water from the canals, indicates that, even with the large amount of organic matter in the bottom of the reservoir, it takes a considerable time for the water to become affected by it to a sufficient degree to give trouble from taste and odor; and in view of the favorable results obtained by cleaning other reservoirs in the State, the Board is of the opinion that, if all the mud and organic matter should be removed from the bottom of this reservoir, so that the soil exposed to the

water would consist of clean gravel or sand, the water would generally be of excellent quality; and, though it might possibly at times be affected by the presence of minute vegetable organisms, which impart to water a disagreeable taste and odor, the troubles from this cause would not be likely to be serious or long-continued, and might be noticed only at long intervals of years, if at all.

The cost of cleaning the reservoir would be large, and it would be necessary, moreover, to provide an adequate supply of water for the city while the reservoir is being cleansed, either by dividing the reservoir into two or more portions, and cleaning a portion at a time, or providing water from some other source; and, considering the character of the water of the reservoir, it would be desirable to supply water of better quality, if possible. Under the circumstances, before proceeding with this undertaking, it is very desirable to determine whether it may not be practicable to purify the water satisfactorily in another way, and at less cost.

From investigations thus far made by the Board, as to results obtained by rapid mechanical filtration of a water of this sort, it appears that by the use of some chemical, usually alum, as a coagulant, a great improvement in the appearance of the water could probably be made, and the greater portion of the organisms and suspended matter could be removed from the water; but in the process of filtration the quality of the water is injured, on account of some of the alum passing through the filter, and it is very doubtful, even then, whether the filtered water would be satisfactory to consumers. The filtration of the water in this way without the use of alum does not give satisfactory results; and, while at low rates of filtration better results might be obtained, the cost of purifying the whole supply of the city satisfactorily by mechanical filtration without the use of alum would probably be prohibitory.

With regard to the filtration of the water through prepared beds of sand and gravel, as carried on in Europe, and at Lawrence in this State, the Board cannot give a definite opinion, since it has no results of experiments upon the filtration in this way of a water containing the vegetable organisms found in the water of Ludlow reservoir during the greater portion of the summer and fall. The elevation of the reservoir above the city is such that it appears to be practicable, by locating filters in the vicinity of the reservoir, to filter the water by gravity, and subsequently deliver it to the city without seriously reducing the pressure in the high service districts. Moreover, there is a considerable area of sandy land near the Ludlow gate-house, from which sand for filtration purposes could apparently be obtained. With these conditions, it is possible that a satisfactory purification of the water could be effected by filtration through prepared beds of sand and gravel, and at a less cost than by emptying the reservoir and removing the soil and vegetable matter from its bottom.

Under the circumstances, the Board would advise that you construct

two small experimental filters in the vicinity of the reservoir, and make experiments upon the filtration of this water during that portion of the year when the water contains an excessive amount of vegetable matter, beginning about the first of May and continuing until nearly the end of the year. The Board will assist you in these investigations, if you desire, by advising you as to the construction and operation of experimental filters, and will make all necessary examinations of water. The Board would further advise that you cause a careful estimate to be made of the probable cost of removing the soil and mud from the bottom of the Ludlow reservoir, so that the surface exposed to the water shall consist only of sand or other material nearly free from organic matter; and that you make an investigation with a view to determining the best method of supplying the city while the cleaning of the reservoir may be in progress, and the probable cost of the works that may be required. When the results of the experiments and investigations are available, the Board will advise you further as to the best method of improving the quality of your water supply.

Swampscott. An application was received, February 15, from the committee on water supply of Swampscott, for the advice of the Board relative to certain alternative plans or sources for supplying the town of Swampscott with water. The Board replied to this application as follows: —

June 4, 1897.

The State Board of Health has considered your application with reference to a water supply for the town of Swampscott, in which you mention four possible sources of supply, and request advice as to which is the most appropriate and desirable for supplying the town of Swampscott with pure, soft water.

The sources mentioned by you are as follows: —

1. Driven wells in the Thompson Meadow and vicinity, in and near the town of Swampscott, operated and controlled by the Marblehead Water Company.

2. Collecting wells near the Forest River, Salem, owned and operated by the town of Marblehead.

3. Storage basins, ponds and Saugus River, the present system of the city of Lynn.

4. The metropolitan system of water supply.

The Board has caused an examination of the first three sources mentioned in your application to be made by its engineers, and has examined the results of analyses of samples of water collected from these sources at various times.

The first source of supply mentioned in your application is the works for taking water from the ground in Thompson Meadow and its vicinity, in

and near the town of Swampscott, which have been constructed very recently by the Marblehead Water Company as an auxiliary source of water supply for the towns of Swampscott and Nahant. Previous to the construction of these works, the Marblehead Water Company, on two occasions, applied to the State Board of Health for its advice with reference to this source, and the replies of the Board are enclosed herewith.

The works for taking a supply from the ground in Thompson Meadow were completed early in the present year, and the Board is informed that since about the end of January water has been drawn from a system of tubular wells located in a line about 500 feet long, beginning at the southerly end of the meadow and running in a north-easterly direction, approximately parallel to the eastern division of the Boston & Maine Railroad, a short distance north-west of it.

Analyses of samples of water collected from time to time since the tests were first made at this place show that the hardness of the water has increased considerably since the source was first used for the supply of the towns, and it is now somewhat harder than is desirable, but in other respects the quality of the water remains excellent at the present time.

The quantity of water obtained has not been sufficient for the supply of the towns at all times, and water has also been drawn from other sources under the control of the Marblehead Water Company during this period. Test wells in the middle and northerly portions of the meadow indicate that the material beneath the surface is of about the same general character as in the southern portion, where the present system of wells is located. Judging from the height of water in several of these test wells, the effect of pumping at the southerly end of the meadow may influence the water over an area of from a third to half its total area, and a larger quantity of water could probably be obtained from the ground if the collecting works were extended through the meadow so as to draw water from all of its area. On the other hand, the present wells have been in use only during the wetter portion of the year, and the quantity obtainable in the drier portion, when the consumption of water is greater, is likely to be considerably smaller than it has been up to the present time.

Considering, also, the limited area of the meadow, the impervious nature of the soil encountered for a considerable distance below the surface in sinking the wells, and the character of the land about it, which appears to be of a ledgy nature and unfavorable to the collection of a large amount of ground water, the Board is of the opinion that there is much doubt as to whether sufficient ground water can be obtained in the meadow to meet the present needs of the town of Swampscott, and it is not probable that the supply would furnish sufficient water to provide for the needs of the town for any considerable time in the future.

The brook which flows through Thompson Meadow drains a nearly uninhabited territory, apparently nearly free from swamp, and it may be

feasible to construct storage reservoirs upon this brook and obtain a supply of good surface water; but with present information it is impossible to estimate at all definitely how large a supply could be obtained in this way, though it is not impossible that a sufficient quantity could be obtained, in connection with the water obtainable from the ground in Thompson Meadow, for the needs of Swampscott for several years in the future.

The second source mentioned in the application is the present works of the town of Marblehead. The sources of supply of this town are two large wells and a system of tubular wells in the valley of Forest River in Salem. The water of the large wells is affected by the presence of an excessive amount of iron, which renders it unsatisfactory for many domestic uses, while the water of the tubular wells, which is used only a portion of the time, has shown indications of the presence of a small amount of sea water.

It is not probable that the sources of supply of Marblehead, as at present developed, would furnish enough water for the supply of Swampscott at all times in addition to the quantity now drawn for the use of the town of Marblehead; and, while it is probably feasible to enlarge the supply of Marblehead by taking water from other territory in the vicinity of the present sources, it is very doubtful whether sufficient water of good quality could be obtained to meet the needs of both Marblehead and Swampscott for a considerable number of years in the future.

The water supply of the city of Lynn, the next source mentioned in your application, is drawn from five storage reservoirs and the Saugus River. The reservoir most recently constructed is located on Hawkes Brook, a tributary of the Saugus River, and its bottom was prepared for the storage of water by the removal of soil and vegetable matter from a portion of the area and by covering the remainder with gravel. In the other reservoirs the brush and wood were removed, but the soil and vegetable matter were allowed to remain; and the water of two of them, Glen Lewis and Walden ponds, while free from sewage pollution, contains such abundant growths of minute organisms during much of the time as to be wholly unsuitable for drinking. The other two, Breed's Pond and Birch Pond, have been in use for a much longer time and furnish water of much better quality, though it is affected by a brownish color which water acquires from contact with vegetable matter in swamps and the bottoms of ponds from which soil and vegetable matter are not removed. The water-shed of Hawkes Brook contains a small but scattered population, but the water-sheds of the other reservoirs are nearly free from population, and the city has acquired large tracts of land about them to protect them from pollution, so that it may be said that the water derived from the natural water-sheds of the reservoirs is practically free from danger of sewage contamination.

Water is at present drawn from Saugus River at Howlett's Dam, and is

either discharged into Birch Pond or conveyed directly to the pumping station and thence distributed to the city. The water-shed of the Saugus River contains a very large population which is not provided with sewers, so that much sewage necessarily finds its way into the streams, and, under the circumstances, this source must be regarded as a dangerous one from which to take water for domestic purposes. The water is of poor quality in other respects also, since it has a high color and contains much organic matter due to its contact with vegetable matter in swamps. Under the circumstances, the Board does not, at present, advise the town to take water from the works of the city of Lynn.

The final source concerning which advice is asked is the metropolitan system of water supply, which is now in process of construction. By the terms of the metropolitan water supply act, the Metropolitan Water Board may furnish water to the town of Swampscott upon such payment of money as the Metropolitan Water Board shall determine. The nearest town to Swampscott that is within the water supply district, at present, is the town of Revere; and, in order that the town of Swampscott may obtain a supply from the metropolitan district, a pipe would have to be laid from some point in Revere to connect with the Swampscott pipes, so far as can be judged at the present time. The works of the metropolitan water supply district are not yet sufficiently advanced to provide water for the towns within the district, and it cannot be predicted at the present time how soon water may be distributed from these works, but probably within the next two years. By taking water from these works a permanent supply of good water could be obtained for the present and future, but the Board is unable to inform you as to the probable cost of works or the conditions under which the water could be obtained.

In view of the circumstances, the Board would advise the town of Swampscott to cause a careful investigation to be made, to determine the feasibility and probable cost of obtaining a supply from the works of the metropolitan district, and also to determine the feasibility of constructing storage reservoirs upon the brook which flows through Thompson Meadow; the probable quantity and quality of water that can be obtained by developing the source in this way, in connection with water from the ground in Thompson Meadow; and the cost, as compared with the cost of a supply from the metropolitan system, taking into consideration the length of time that a supply from Thompson Meadow and its vicinity would be likely to last.

The Board will advise you further in regard to this matter, if you desire, when you have the results of further investigations to present.

WALTHAM. An application was received Dec. 26, 1896, from the mayor of Waltham, requesting information upon the following points: —

"(1) Is the present condition of the water supply such that it is necessary to make an immediate extension of the sewer system to take in the area known as Crescent Park?

"(2) Would not such an extension of the sewered district stop wholly or in part the increase of iron in the city water?"

The Board replied to this application as follows: —

June 10, 1897.

With regard to the need of extending your sewerage system for the purpose of removing the sewage from the populated territory on the opposite side of Charles River from your water works not at present provided with sewerage, the Board has already expressed the opinion, in a previous communication, that the quality of your water supply is threatened by cesspools and sewage from the population on this territory, from which a part of your water supply undoubtedly comes, and that the abolition of cesspools and the diversion of sewage from this territory into the metropolitan system should be provided for without delay. Analyses of the water of the filter basin in recent years show that the water, before passing through the ground to the filter basin, is being polluted in an increasing degree, and, though subsequently purified in a large degree in its passage through the ground, reaches the basin with more impurity from year to year; and the Board advises that it is important to remove the sewage from all territory from which water percolates toward the well.

With regard to the second question, as to whether such an extension of the sewered district would stop wholly or in part the alarming increase of iron in the city water, it can be said that the increase in iron is probably due, in part, to the imperfect purification of water entering the filter basin by filtration through the ground from the river, and in part, also, to water which is subject to pollution in a greater or less degree which reaches the filter basin by passing through ground containing iron, and that it is probable that any increase in pollution will cause the water to take up an increased amount of iron as it passes through the ground.

With the rapid increase in consumption of water from the filter basin, the area from which water is drawn toward the basin is enlarging, and the removal of impurities which now enter the water from the single district mentioned in the application will prevent only to a very limited degree the further increase of iron in the water. The indications are that the quantity of iron, which has increased rapidly in the past three years, although the quantity thus far has been too small to be noticed by consumers, will continue to increase with the increase in the quantity of water drawn through the ground, owing both to the increased rapidity with which water passes through the filtering material, and probably, also, to the greater area of territory drained which supplies iron.

The only remedies which the Board, with its present information, can

suggest are to remove as completely as possible all sewage from the territory which supplies water to the filter basin, and to diminish the draft from this basin so that it shall not exceed, at most, the amount drawn four years ago before the iron began to increase, and to seek another source for the additional water required for the supply of the city.

WAREHAM, MARION, MATTAPOISETT and FAIRHAVEN. An application was received, Nov. 1, 1897, from Mr. Joseph K. Nye of Fairhaven, for the advice of the Board with reference to the propriety of taking certain sources of water supply for the towns of Wareham, Marion, Mattapoisett and Fairhaven. The Board replied to this application as follows: —

JAN. 6, 1898.

The State Board of Health received from you, Nov. 1, 1897, an application for advice with reference to a proposed water supply for the towns of Wareham, Marion, Mattapoisett and Fairhaven, in which you refer to Jonathan's Pond, the present source of supply of the village of Onset, and to the valley of the Agawam River, as the sources which you have under consideration. It further appears that in taking water from the valley of the Agawam River you propose to use Iron Works Pond, so called, a reservoir formed by the Agawam dam in the town of Wareham, as the direct source of supply.

With reference to the quality and quantity of water obtained from Jonathan's Pond, the Board has already advised, in a communication dated June 9, 1894, as follows: —

> The Board has caused an examination of this pond and an analysis of its water to be made, and finds that the water is very soft, and of excellent quality for all the purposes of a public water supply.
>
> The limits of the territory which contributes to the supply of the pond, either by direct flow over the surface or by filtration under ground through the sandy territory in which the pond is situated, are not well defined; and it is not, therefore, practicable to determine at all definitely the quantity of water which this source will furnish. It seems probable, however, that it will furnish the water required for the portion of the town of Wareham which the company is authorized to supply from it.

More recent analyses of the water of Jonathan's Pond tend to confirm the opinion expressed at that time as to the quality of the water furnished by the pond. With regard to the quantity of water which this source will yield, no important additional data have been supplied which would make possible a more accurate estimate than the one given in the previous reply; but, so far as can be judged from the location of the pond and the probable area from which water would drain toward the pond if a considerable

quantity should be drawn from it, it is improbable that it would furnish enough water for the supply of the other towns mentioned in your application.

The quantity of water which Iron Works Pond and its tributaries would furnish would be much more than would be needed by the town of Wareham, and would be ample also for the other towns mentioned in the application.

The results of a single set of analyses of samples of water collected recently from Iron Works Pond, Spectacle Pond and the Agawam River, showed that the water of Iron Works Pond at that time, while having considerable color, was of fairly good quality for the purposes of a public water supply; the water of the Agawam River, at the old Glen Pond dam, was found to be of about the same quality as that of Iron Works Pond; but the water of Spectacle Pond and of the Agawam River, just below the outlet of Halfway Pond, was of inferior quality and contained a considerable quantity of suspended matter, which was found to consist of microscopic organisms, some of which were of kinds which have been known to cause disagreeable tastes and odors in the water of other ponds and reservoirs. Whether the quality of these waters would differ materially at other seasons of the year from what it was found to be at the time of this examination cannot be predicted from the information thus far available; but there appears to be a shallow area near the upper end of Iron Works Pond, where stumps are decaying, which may have an unfavorable influence upon the quality of the water of that source in the warmer portion of the year; and, considering also the character of the organisms found in the water of Halfway and Spectacle ponds at the time of this examination, the indications are that the water of Iron Works Pond may be subject at times to disagreeable tastes and odors. To determine with reasonable accuracy what the quality of the water of this source is likely to be, analyses of the water of Iron Works Pond and its various tributaries should be made at frequent intervals for at least a year.

A good ground water would be much more satisfactory than the water of Iron Works Pond, on account of its freedom from color and from disagreeable tastes and odors; and, so far as can be judged from the character of the surface of the ground in the vicinity of Iron Works Pond, the conditions appear to be favorable for obtaining water in large quantities from the ground. It is very desirable that, in further investigations relative to obtaining a water supply from this source, the feasibility of obtaining a supply of good water from the ground in the vicinity of the pond should be considered.

If further investigations should show that water of suitable quality could be obtained from Iron Works Pond or its neighborhood, this source would probably be an appropriate source for the town of Wareham; but whether it would be the most appropriate source for the supply of the other towns

the Board cannot undertake to advise without a more thorough investigation than appears to have thus far been made.

The Board would advise that an investigation be made to determine the probable quality of the water to be obtained from Iron Works Pond, and the feasibility of obtaining a sufficient quantity of good ground water from its neighborhood for the supply of the towns mentioned in the application. At the same time, all other available sources of supply for these towns, or for any of them, should be carefully considered, and information collected as to the quality and quantity of water that may be obtained from such sources. Such an investigation is necessary before it is practicable to advise as to the most appropriate source or sources of supply for the towns mentioned in the application.

The Board will assist in any further investigations by making analyses of such samples of water as may be necessary, and will, upon application, give you further advice in the matter when you have the results of further investigations to present.

WATERTOWN. The Watertown Water Supply Company applied to the Board, Nov. 28, 1896, for its advice with reference to a plan for filtering the water of certain wells by means of a "system similar to that now in use at Reading, Mass." The Board replied to this application as follows: —

DEC. 3, 1897.

The State Board of Health received from you, on Nov. 28, 1896, an application for advice with reference to filtering the water of a system of tubular wells, located about 1,000 feet east of your present pumping station and near the northerly bank of Charles River, by means of a mechanical filter plant similar to the one now in use at Reading, Mass., either with or without the use of alum. It is understood that water from these wells is used for an auxiliary supply in the summer season only, the filter gallery and driven wells near the pumping station furnishing sufficient water at other seasons of the year, and that the water is objectionable for many domestic uses, chiefly on account of the presence of an excessive amount of iron.

At the time the application was made, a mechanical filter had been in operation at Reading for a period of about four months, filtering the water supply of that town, which is drawn from a filter gallery, and which resembles that drawn from the auxiliary wells at Watertown in that it contains an excessive amount of iron, and several analyses of the water, both before and after filtration, had been made by the Board. Just before filtration, solutions of lime and alum were added to the water, and the examinations of the effluent showed that nearly all of the iron was removed and the appearance of the water greatly improved by the process; but it was found that alum was present in the filtered water, and that the

water was very hard, its hardness being several times as great as when drawn from the ground. Under the circumstances, it did not seem to the Board that the improvement effected was an offset to the possible injury to health from the use of so hard a water, containing also a considerable quantity of alum. Moreover, the probable cost of constructing and operating a filter plant of this sort is large, considering that its use would probably be rendered unnecessary when a metropolitan water supply, the works for which are already under construction, shall have become available, since both Watertown and Belmont were included in the metropolitan district.

Whether the water could be freed from iron by filtration alone, without the use of a chemical as a coagulant, was not definitely known; but previous experiments on a small scale had indicated that the iron could not be removed in this way, unless, perhaps, by filtration at a comparatively slow rate, which would probably be much more expensive than filtration through an ordinary sand filter.

With a view to learning whether it was practicable to purify this water by filtration through an ordinary sand filter, without the use of chemicals, the Board has caused experiments to be made at your works by filtering the water after aeration through a bed of fine sand. The results obtained indicate that practically all of the iron can be removed from this water by aeration and subsequent filtration through sand at a rate of about 10,000,000 gallons per acre per day, and possibly somewhat greater, and that the hardness of the water is not increased by the process.

It appears that the soil in the vicinity of your filter gallery beneath a surface layer of loam consists of a coarse gravel extending down to the bottom of the gallery, which is approximately 15 feet below the level of the water in the river. Late in the past season a small area of this land, located about 100 feet from the gallery, was cleared of loam, and water from the wells pumped upon the surface of the gravel, with a view to increasing the yield of the filter gallery by water filtering through the ground from this area. The results indicate that the yield of the filter gallery may be materially increased in this way; and, as there appears to be coarse soil for a considerable distance about the filter gallery, it seems probable that its yield may be increased sufficiently to furnish all the water required. It is probable that, after filtering 100 feet through the ground, the iron in the water will be reduced to such a degree that it will not give serious trouble, — at least during the time that seems likely to elapse before the metropolitan water supply will be available.

The Board is, therefore, of the opinion that it would be best to increase the supply of water from the filter gallery by turning water from the wells upon the surface of the gravel in the vicinity of the gallery, rather than to construct a special plant for filtration purposes, which would probably be needed for a short time only.

WELLESLEY. The committee on water supply of the town of Wellesley applied to the Board, Oct. 15, 1896, submitting the report of their engineer upon a proposed additional water supply for the town, and requesting the advice of the Board thereon. The Board replied to this application as follows: —

FEB. 4, 1897.

The State Board of Health received from you, on October 15, an application for advice with reference to a proposed additional water supply for Wellesley, in which you stated that, in accordance with the recommendations contained in a previous reply of this Board, you had employed an engineer to make investigations relative to an additional water supply. Subsequently, on January 18, you submitted a report of Mr. Desmond FitzGerald, C.E., containing an account of the investigations, with his recommendations as to increasing the water supply of the town of Wellesley, and requesting the advice of the Board thereon.

Several sources of supply are considered in the report, and it is recommended that the use of the present sources be continued, and that they be supplemented by water collected from the ground in the valley of Rosemary Brook, in the Burnett Meadow, so called, between Cedar Street and Longfellow's Pond, by means of tubular wells connected with a suction main laid from the present pumping station. Since it is thought that the quantity of water obtainable in this way will be limited, two methods of obtaining a further supply are proposed, one by charging the ground underlying the meadow in which the wells are located with water from the brook, and another by constructing artificial filter beds to filter the water of Rosemary Brook as it flows from Longfellow's Pond. It is recommended that an experiment be made to see whether satisfactory results can be obtained by the first method, and, if these are not satisfactory, that the second be adopted. It is also recommended that a covered distributing reservoir be constructed on Maugus Hill, and that the present open reservoir be kept for use in case of emergency.

The Board has carefully considered the proposed plan, and has caused an examination of the territory to be made by its engineer and samples of water from test wells in the Burnett Meadow to be analyzed.

The quality of the water of these wells, though affected to some extent by the presence of several houses in the valley of the brook, is, in its present state, excellent for the purposes of a public water supply, and showed no deterioration during a pumping test made by connecting several of the wells together and pumping from them with a steam pump for a period of about one week.

From the tests made by your engineer, as described in his report, it appears that the soil in the valley of Rosemary Brook from the pumping station to a point about 700 feet west of Cedar Street is largely composed

of fine material, but that beyond this point strata of gravel were reached by the test wells from which water could be pumped with considerable freedom, as shown by the pumping test referred to, during which the yield of the wells averaged about 300,000 gallons per day. It is possible that the yield would have been larger had some of the wells south of the Worcester turnpike been connected with the pump. While this quantity of water, if it could be obtained continuously, would be sufficient, in connection with the present sources, to supply the town until the consumption of water shall have become double what it is at present, it is probable that the yield of this source will at times fall considerably below 300,000 gallons per day; so that, while the indications are that a material addition to your present supply can be obtained from the wells in this locality, a further additional supply is likely to be necessary within a very few years.

It is very desirable, in providing an additional supply of water, that a source be selected that is capable, not only of meeting the immediate needs of the town, but of being developed so as to furnish a supply for a considerable time in the future at a reasonable cost. As already indicated, two ways are suggested by your engineer for obtaining a further additional supply when the needs of the town may make it necessary, one by turning the water from the brook upon the ground in the vicinity of the wells, to assist in saturating the ground, and the other by filtering the water through prepared beds of sand, as is done at Lawrence in this State.

With regard to the first method, — the saturation of the ground by turning brook water upon it after the removal of the surface soil, — it will be necessary to find a place where the underlying sand is sufficiently permeable; and, owing to the variable stratification, it is not feasible to tell whether a material increase in the supply could be obtained in this way; but if satisfactory results could be obtained and the quality of the water shown to be good, it would be a suitable method of increasing the supply.

With regard to the second method, — that of filtering the water through prepared beds of sand, — there is no doubt that a safe water for drinking could be obtained from filters properly designed and constructed, and operated with care. In either case, it would be necessary that the watershed of the brook be subjected to careful inspection, to prevent its pollution by sewage, so far as possible; and, considering the nearness of the present sources to the brook, the purity of its water should be carefully guarded in any case.

From the investigations thus far made, the Board is of the opinion that it is desirable to continue the use of the present well and filter gallery, taking care that brook water is not allowed to enter them without purification by filtration through the ground, and to increase the supply by taking water from the ground in the valley of Rosemary Brook in the vicinity of the test wells, as proposed. As already stated, the present indications are that, with the increase of population and in the use of water, this

source may become inadequate within a very few years; and, unless in the construction of permanent works the indications shall be much more favorable than at present for a large yield of water, it is desirable that you continue your investigations as to further supplementing the supply when it shall become necessary by saturating the ground about the wells with brook water, as suggested in the report of your engineer.

In the previous reply of the Board it was suggested that, judging from surface indications, favorable conditions for obtaining water in considerable quantity from the ground were found near the upper end of Longfellow's Pond, but the tests recently made do not appear to have been carried to this territory. In view of the nearness of this locality to the proposed wells in the Burnett Meadow and the apparently favorable conditions that exist here for obtaining water from the ground, the Board would again advise that tests be made here to determine whether it is feasible to obtain a further additional supply by extending the proposed collecting system in this vicinity.

The Board would also advise that you make provision for delivering the water to consumers without exposure to light. Experience has shown that a ground water rapidly deteriorates when exposed to light in an open reservoir, such as the one now in use at Wellesley; but all trouble from this cause will be avoided by keeping the water from exposure to light from the time it is drawn from the ground until it reaches the consumer.

The Board will, upon application, assist you in any further investigations that you may wish to make, and advise you again with reference to your future water supply when you have the results of additional investigations to present.

WESTON. An application was received, Aug. 30, 1897, from Charles W. Hubbard of Weston, for advice as to a proposed water supply for several houses in the south-east part of Weston, certain places being indicated in the application as appropriate sources of supply. The Board replied to this application as follows: —

OCT. 8, 1897.

The attention of the Board has been directed to three possible sources of supply, all of which are in the vicinity of a small tributary of Charles River, which flows into that stream from the north-west at a point about one-third of a mile north-east of the Wellesley Farms railroad station.

The first source is a spring near the upper end of the brook, near which it is proposed to locate a collecting well. It is expected that this well could be fed by water filtering from a small pond, to be formed by constructing a dam across the brook a short distance below the well; and it is proposed to keep up the level of the pond by diverting into it water from a small pond about 500 feet north-west of the proposed well.

The second source suggested for consideration is a well on the south-westerly side of the brook, about 2,000 feet farther down the stream than the first-mentioned source, following the course of the brook, and just above a highway.

Finally, you suggest a ground-water supply from the vicinity of Charles River, near the mouth of the brook.

The Board has carefully considered your application, and has caused the territory to be examined by its engineer and samples of the water from the sources mentioned to be analyzed. An analysis of the water of the spring near the upper end of the brook, where it is proposed to locate the first-mentioned well, indicates that the ground water at this place is soft, and otherwise of good quality for the purposes of a domestic water supply; but the water-shed of the brook in the vicinity of this well is so small that the quantity of water which a well in this locality would furnish is likely to be entirely inadequate for the needs of the population which it is intended to supply. By constructing a reservoir below this well, it is possible that the quantity of water that would enter the well might be somewhat increased by the filtration of water through the ground from the pond; but, judging from the appearance of the surface of the ground in the vicinity, the soil is of such a character that it is not probable that any considerable quantity of water would filter through the ground from the pond into the well. The quantity of water entering the pond could be somewhat more than doubled by drawing water from the pond 500 feet north-west of the spring; but drawing water from this source into the proposed pond near the well would not materially increase the supply to be obtained from the ground in the vicinity, unless the material is more porous than the appearance of the surface would indicate. A much larger supply could be obtained from these sources if the waters of the brook and pond could be taken directly, in connection with the water of the well; but these sources, taken together, would not probably furnish a sufficient supply at all seasons of the year; and, moreover, an analysis of the water of the pond 500 feet north-west of the spring shows that it contains so large an amount of organic matter that it would be a very unsatisfactory source of domestic water supply.

The second source referred to is a well close to the brook at a place farther down stream, where the water-shed of the brook is much larger; but an examination of the water of the well shows that it is of poor quality for domestic uses, and it is not probable that a sufficient quantity of water could be obtained from this source for the supply of the population at all times. A much larger quantity of water could be obtained by using water taken directly from the brook in connection with water from the well; but the brook at this place might not be a safe source from which to take water directly for domestic uses.

The conditions in the vicinity of Charles River, near the mouth of the

brook, are favorable to obtaining water freely from the ground in the vicinity of the place indicated upon the plan submitted, and there is reason to expect that water obtained in this way would be of good quality. The well or other works for collecting ground water in this region should, however, be located at a sufficient distance from the river to avoid danger of any imperfectly filtered water from the river entering the source of supply.

The Board would, therefore, advise that you make a further examination to determine the feasibility of securing an ample supply of good water in the vicinity of Charles River, at the place suggested by you in your application.

The Board would also call attention in this connection to the plans for a general system of water supply for the city of Boston and other municipalities included within the metropolitan district, which includes, as a part of the system, a large distributing reservoir to be constructed near Doublet Hill, so called, in Weston, not far north of the district in which the houses which you propose to supply are located. From present indications, this reservoir may be constructed within a few years; and, while it will not be at a sufficient elevation to deliver water to your present stand-pipe without pumping, it will, nevertheless, be at such an elevation that the cost of pumping the water of this reservoir into your present works would be small compared with the cost of pumping from the well near Charles River, and under the terms of the metropolitan water supply act an arrangement could probably be made to obtain water from these works. Under the circumstances, it may be desirable to provide temporary works, so far as practicable, with a view to obtaining a supply in the future from the works of the metropolitan district when this reservoir shall have been completed, and effect a saving in cost over the construction at the present time of works designed to be more permanent.

Sewerage and Sewage Disposal.

The following is the substance of the action of the Board during 1897 in reply to applications for advice relative to systems of sewerage and sewage disposal: —

Abington. An application was received, Aug. 13, 1897, from the board of health of Abington, for the advice of the Board relative to the disposal of the surface-water drainage from the vicinity of the factory of M. N. Arnold & Co., in that town. The Board replied to this application as follows: —

Sept. 10, 1897.

The State Board of Health received from you, on August 13, an application for advice with reference to the disposal of surface-water drainage from the vicinity of the factory of M. N. Arnold & Co., on Wales Street

(formerly Cross Street), in the village of North Abington, and has caused an examination of this locality to be made by its engineer.

It appears that the proposed drain will receive the drainage of a limited area in the immediate vicinity of the factory, and that there are no other buildings at present located upon this area. It is understood, also, that no water from any other source is to be discharged into the proposed drain than that which naturally enters the depression in which the spur track from the New York, New Haven & Hartford Railroad is laid at the factory. The proposed drain will discharge into one of the feeders of the Whitman water supply, which is taken from the stream at a point a little less than four miles below the proposed point of discharge of the drain, and for this reason it is necessary that all sewage or other matter which would tend to pollute the water supply of Whitman shall be kept out of the drain.

The only source from which it might be possible for sewage to find its way to the drain at the present time appears to be the vault used by the factory operatives; and, from information furnished as to the construction of the vault and the frequency with which it is cleaned, there does not seem to be any danger of the pollution of the drain from this source, providing that care is exercised in removing the contents of the vault, that none of it is allowed to remain on the surface of the ground in the vicinity.

It is understood that a change is to be made in the present vaults in the near future, in order that carts may be driven under them to receive their contents. In this case there might be danger that, if there was any leakage from the vaults, it would find its way into the proposed drain, but the vaults can be so constructed that it will be feasible to drain the area beneath them into the present sink-water drain, which passes in a southeasterly direction from the factory and discharges in another water-shed; and, if provision is made for removing any leakage that may occur in this way, the danger of the proposed drain being polluted from the vaults would be removed.

The drainage from the territory about the factory under present conditions finds its way naturally, either directly or indirectly, into the brook into which it is proposed to discharge the drain; and the Board is of the opinion that the disposal of the drainage in this manner is permissible, provided that due precautions are taken to prevent any danger of sewage entering the drain from the present vaults, or from any vaults which may be built in the future in the vicinity of the factory or along the course of the drain.

Danvers. The advice of the State Board of Health to the board of health of Danvers in regard to the disposal of the sewage of certain morocco factories in that town is presented in the report of the Board to the Legislature, dated Jan. 11, 1897, page 50. On July

17, 1897, the board of health of Danvers again applied to the State Board of Health, requesting its advice with reference to the disposal of the sewage of these factories by means of settling tanks. The Board replied to this application as follows : —

AUG. 7, 1897.

The State Board of Health received from you, on July 17, 1897, an application for advice with reference to the construction and operation of settling tanks for the removal of suspended matters from the sewage of the tannery of Messrs. Bernard, Friedman & Co., in Danvers.

Accompanying the application were plans showing four settling tanks, which you state will have an aggregate capacity of 73,852 gallons, equal to the volume of sewage discharged from the tannery in about three and one-half hours, and showing also the proposed location of these tanks. You also state that you have the assurance of the proprietors of the tannery that they will construct tanks suitable and satisfactory to your board, that they will pump the sewage to the tanks, and take care of all of the sludge which may be collected.

The Board has carefully examined the proposed plans, and concludes that the tanks are of sufficient size to provide for the removal of all of the organic matter that it is practicable to remove from the sewage by means of settling tanks alone. The plans provide for operating the tanks separately or together, but in order to secure the best result it will be necessary to operate the tanks separately; that is, after a tank is filled, the sewage should be diverted from it and it should be allowed to stand undisturbed for as long a time as is practicable. If the flow of sewage is no greater than is anticipated, each tank may be allowed to remain undisturbed for a period of two hours and possibly more, depending upon the length of time required to draw off the supernatant liquid.

By the plans submitted, it is proposed to draw off the supernatant liquid from each tank through a pipe in the side of the tank, and there appears to be no means of drawing from any other level than the one at which this pipe is placed. If the sludge in the tank should be allowed to rise above the level of the bottom of this pipe, some of it would be drawn off with the liquid; and, even with the surface of the sludge slightly below the bottom of the pipe, there is danger that some of it might be drawn out by the current created by the outflowing liquid, and some means of preventing this danger of drawing off sludge with the supernatant liquid should be provided.

It seems probable that, if the tanks are constructed of the size proposed and operated with such care as to remove all sludge that it is practicable to remove by sedimentation, about half of the total organic matters can be removed from the sewage in this way, and this would include by far the larger portion of those matters which cause trouble by settling to the

bottom of the pond below the tannery; but the supernatant liquid would still contain a very large amount of organic matter, and investigations have been carried on by the Board since your previous application was made, with a view to finding a practicable method for its purification.

In the course of these investigations it has been found that the sewage contains a chemical which is used in packing the skins to prevent their decomposition in the course of shipment to the tannery, and that a large quantity of arsenic is used in a process carried on in the tannery. These matters arrest bacterial action, and it is not practicable to purify the sewage by filtration until they are removed.

The investigations thus far made indicate that a large proportion of the arsenic is precipitated with the sludge by allowing the sewage to settle, but after sedimentation the supernatant liquid still contains enough arsenic to check bacterial action. It has been found, however, that by passing the sewage through a filter composed of coke the arsenic is completely removed, and by subsequently filtering the sewage through beds of sand or gravel at about the same rate as ordinary town sewage may be filtered, a satisfactory purification of the sewage can be effected.

An examination of the territory in the vicinity of the tannery shows that suitable land for filtration is found south of Purchase Street and not far from the tannery, but at a considerably higher elevation. In order to use this land it would be necessary either to pump all the sewage to a greater distance and to a considerably greater height than is now proposed, or, if the settling tanks were located at the place now proposed, to pump the effluent from the tanks to this land. The cost of the works and of their maintenance would, of course, be much greater than the cost of operating settling tanks alone, but this seems at the present time to be the only practicable method of purifying this sewage completely.

Considering the comparatively large cost of purifying the sewage completely in this manner, however, it may be allowable to first construct and operate the settling tanks alone and allow the supernatant liquid to flow into the stream, since it is possible that the improvement effected in this way may be sufficient to prevent further serious trouble for a considerable time; but, if the use of the tanks is found inefficient in preventing further trouble, the sewage can then be purified in the manner already described. The efficiency of the tanks in removing sludge from the sewage and preventing trouble from the pond will, of course, depend largely upon their careful management, and especially on the care with which the supernatant liquid is drawn off to avoid drawing off any of the sludge, and the frequency of the removal of the sludge from the tanks, in order to prevent reducing their capacity materially by allowing the sludge to accumulate to a considerable depth in their bottoms.

It may also be said that, should the town construct a sewerage system before many years, it may be found of advantage to dispose of the tannery

sewage in connection with that of the town. In such a case, settling tanks similar to those now proposed would still be necessary, in order to prevent the heavier matters of the tannery sewage from entering the sewers.

As stated in the previous reply of the Board, the condition of the mill-pond is such that, even if the discharge of sewage into it should be wholly prevented, it is possible that there would still, for a considerable time, be a serious odor from the bottom and sides of the pond when exposed. It has been suggested that the deposits of organic matter be removed from the pond above the level of low water; and this method, if practicable, would be likely to be effective in preventing an odor from the pond. Much relief might, however, be obtained by keeping the pond full at all times, so as to keep the deposits of organic matter covered with water.

DANVERS LUNATIC HOSPITAL. The trustees of this hospital applied to the Board, July 15, 1897, for its advice with reference to the disposal of the sewage of the hospital in accordance with certain plans of the Pennsylvania Sanitation Company submitted with the application. The Board replied to this application as follows: —

DEC. 10, 1897.

The plans provide for the filtration of the sewage through a filter consisting of three separate beds of filtering material, one to be composed of coke and the others of sand. The coke filter is to have a depth of 15 inches and a total area of 128 square feet. It is to be divided into two compartments of 64 square feet each, and only one compartment is to be used at a time. From this filter sewage is to pass to the first sand bed, which is also divided into two equal compartments, each having an area of 1,326 square feet, or about one thirty-third of an acre. After passing through this sand bed the sewage is to fall upon the second sand bed, which is situated directly beneath the first one and is also in two compartments, each having an area of 1,728 square feet.

You state that the sewage of the hospital will amount to approximately 150,000 gallons per day, and measurements made by the Board on a single day under apparently ordinary conditions indicate that this is about the average quantity of sewage flowing from the hospital at the present time. With this quantity of sewage flowing, the rate of filtration through the coke bed would be about 50,000,000 gallons per acre daily; the rate through the first sand bed would be about 2,500,000 gallons per acre daily and through the second sand bed about 1,900,000 gallons per acre daily, when both compartments of each bed are in use. But, in order to secure intermittency in the application of the sewage, the rates of filtration would have to be much greater than the rates given.

Experiments made by the Board upon the filtration of sewage through a layer of coke 15 inches in depth show that 150,000 gallons of sewage per

day cannot be made to pass through a bed of coke of the area and depth proposed for this filter, if the pieces of coke are fine enough to enable the bed to remove any considerable portion of the organic matter from the sewage.

Experiments upon the filtration of sewage through a layer of sand 12 inches in depth, a considerable quantity of organic matter having first been removed from the sewage by straining through a layer of coke 15 inches in depth, show that, at the rate of filtration which you propose for the filter at Danvers, the sand very quickly becomes clogged; and, while the sewage can be made to pass through for a time by very frequent disturbance of the sand, the filter will soon become clogged to such a degree by the storage of organic matter from the sewage that it will be necessary to remove the sand entirely and replace it with clean sand to keep the filter in operation. Such an amount of sewage as can be made to pass through the first sand filter will probably pass through the second sand filter for a considerable time without trouble; but our experiments indicate that the resulting effluent may still contain a large amount of unoxidized organic matter.

As a result of its investigations, the Board concludes that it is entirely impracticable to attempt to purify the sewage of the Danvers Lunatic Hospital by means of the filter proposed in your application.

In accordance with advice contained in a previous reply of the Board, you have caused investigations to be made to determine the feasibility of disposing of the sewage of the Danvers Lunatic Hospital upon an area of about four acres of land now owned by the hospital in the vicinity of the Ipswich River; and you submit plans and a report by J. J. Van Valkenburgh, civil engineer, upon the feasibility of preparing a filtration area at this place, and its probable cost.

This land appears to be the most favorable of any in the vicinity of the hospital for sewage-disposal purposes. The investigations of your engineer show that the material varies greatly in different portions of the area, a portion of it being of excellent quality for filtration purposes, while other portions are somewhat finer than is desirable. There appears also to be a stratum of clay beneath a portion of the area.

The investigations of your engineer show that it is feasible to prepare at this place filter beds having an area of 2.2 acres, which will consist of excellent soil for filtration purposes, and an area of about 1.1 acres of less satisfactory soil, but of a quality which can be used for the purpose with suitable underdrainage.

The plans also provide for a flush tank to be located on the main line of sewer between the hospital and the filtration area, and designed to discharge its contents intermittently to secure an equal distribution of sewage upon the filter beds.

The Board has caused examinations of the soil of the proposed filtration

area to be made, and, having carefully considered the proposed plans, concludes that this plan, if properly carried out, will provide satisfactorily for the disposal of the sewage of the institution, and is the best plan that it appears to be feasible to adopt. It is suggested that the proposed filtration area might be divided into a larger number of beds and the flush tank made somewhat smaller, effecting thereby a reduction in the cost.

HAVERHILL. An application was received, Nov. 27, 1897, from the mayor of Haverhill, for the advice of the Board with reference to a proposed system of sewerage and sewage disposal for a district in the south-east part of the city known as Riverside. The Board replied to this application as follows: —

JAN. 7, 1898.

The State Board of Health received from you, on November 27, an application for advice with reference to a proposed system of sewerage and sewage disposal for that portion of the city known as Riverside, and with reference to constructing a proposed overflow sewer, to avoid overtaxing the capacity of the Primrose Street sewer at times of heavy storms by discharging a portion of the mingled sewage and storm water into Little River.

The application was accompanied by plans of the system of sewerage at Riverside and of the proposed overflow from the Primrose Street sewer into Little River.

The Board has caused the localities to be examined by its engineer, and has carefully considered the proposed plans. The plan for the sewerage of the village of Riverside provides for the collection of both sewage and storm water into three sewers, which are to discharge at Adams Street, Munroe Street and Polk Street. The main sewer in Adams Street and its outlet have already been constructed, and the sewage is discharged in this case at the edge of the river bank, above the level of low water, and it is understood that the other outlets are to be similarly located.

The proposed method of disposal of the sewage by discharging it into the Merrimack River is the best that it is practicable to adopt; but the Board is informed that the river bank in this region is likely to be used to a great extent in the future as a park and place of resort in the summer season, and it is essential, in order to avoid a nuisance along the river bank, that at least the ordinary flow of sewage be conveyed a sufficient distance from the bank to prevent floating matters from returning and collecting at the shore, and to prevent, so far as possible, trouble from odors in the vicinity of the outlets. The present sewer outlet at Adams Street is objectionable in these respects. It has been found practicable, in other places where the conditions are similar, to discharge the mingled sewage and storm water, at times of heavy storms, near the shore, and to provide a pipe of sufficient capacity to convey the ordinary flow of the sewer to a

point of discharge well out into the stream, from which sewage is not likely to return to the shore unless after thorough dilution, and the Board would advise that some such method be adopted in the case of the sewers at Riverside.

The proposed overflow from the Primrose Street sewer discharging into the Little River appears to be adequate to remove all of the storm water that is likely to reach it for a long time in the future, and will probably afford a satisfactory relief to the Primrose Street sewer. It will also furnish a method for removing surface water from the small district bounded by Primrose, Maple and Hale streets, and the street through which the sewer is to pass and from about ten acres east of Primrose Street.

The overflow sewer will discharge into an arm of a mill-pond on the Little River, about 1,700 feet above the lowest dam on that stream. There are no houses on the easterly side of the river in the immediate vicinity of the outlet, though it is not unlikely that this district may be built up before many years. The opposite side of the stream is quite densely populated close down to the shore. From information furnished by you, it appears that the sewer has overflowed but twice for a period of two years, so that the quantity of sewage that would be discharged into the river under present conditions would be very small. If any considerable quantity should be discharged at this place, the solid matters would tend to collect upon the bottom of the mill-pond around and in the vicinity of the outlet, and at times of low water in the summer season the exposed portions of the shore might become offensive. It appears to be practicable to dispose of the sewage from this overflow by discharging it below the dam, but the expense would be much greater than at the place proposed.

In view of all the circumstances, the Board is of the opinion that it is permissible to discharge the mingled sewage and storm water overflowing from the Primrose Street sewer at the place shown upon the plans until the quantity of sewage overflowing into the river becomes considerably larger than it is said to be at present. If in the near future it is found that the overflow is operating frequently in ordinary showers, storms or thaws, or if trouble is experienced from the discharge of sewage into the river, the sewage should be disposed of in some more suitable manner, probably by discharging it directly into the Merrimack River.

HULL. An application was received, Oct. 29, 1897, from the committee on sewerage of the town of Hull, for the advice of the Board relative to a proposed system of sewerage for that part of the town known as Point Allerton Hill, having a proposed outlet into the sea. The Board replied to this application as follows: —

DEC. 3, 1897.

The State Board of Health received from you, on October 29, an application for advice with reference to a proposed sewerage system for the

portion of the town of Hull known as Point Allerton Hill, accompanied by a plan showing a system of sewers for an area of about 60 acres, having a point of discharge in the main ship channel on the northerly side of the hill, about 1,800 feet westerly from the beacon at Point Allerton.

You propose in the beginning to discharge the sewage at a point just beyond the low-water mark, and to provide a tide gate in the sewer that will prevent sewage from being discharged on the latter part of the rising tide. It is also proposed to construct a storage tank in connection with the works when the quantity of sewage may make it desirable.

The Board has caused an examination of the locality to be made by one of its engineers, and has carefully considered the proposed plan. The proposed system appears to provide satisfactorily for the sewerage of the district which it is designed to serve, and the place and method of disposal appear to be as satisfactory as it is practicable to secure.

The Board is, therefore, of the opinion that the plan is an appropriate one for disposing of the sewage of this territory. If the plan is carried out, it would still be practicable to intercept sewage from this sewer and convey it in another direction, if in the future it shall be found desirable to provide a general system of sewerage for this peninsula.

LEICESTER. The water commissioners of the Leicester water supply district applied to the Board, Oct. 23, 1896, for its advice relative to the disposal of the sewage of the district upon land in the town of Leicester. The taking of this land was approved by the Board after a public hearing held at the office of the Board, April 15, 1897, and on May 6 the Board replied with reference to the method of disposal as follows: —

On the fifteenth day of April, 1897, upon a public hearing and after consideration, the State Board of Health voted unanimously to approve the taking, by purchase or otherwise, by the Leicester water supply district, of land in the town of Leicester, in Massachusetts, for sewage-disposal purposes, according to a plan submitted by the water commissioners of said district, dated Oct. 23, 1896, said land being bounded, measured and described as follows: —

A certain tract of land situated about half a mile south-westerly of the centre village, containing about 8 acres, bounded and described as follows, to wit: beginning at the corner of a stone wall near the settling tank house, at a point marked A on the accompanying plan; thence running north 33¾° east 120 feet as the wall now stands, thence turning at right angles and running north 86¼° west 170 feet on land of Rawson Light and Power Company to the brook; thence southerly on said brook and Dutton's pond, so called, to land of Edward C. Waite; thence south 78¼° east 60 feet to land of John N. Murdock; thence north 40° east 315 feet to a point; thence due east 310 feet to a point; thence north 30¾° east, on land

of Joseph Murdock, 563 feet to a point; thence south 77° 10′ east 263 feet to the place of beginning; said tract being partly land of Rawson Light and Power Company and partly land of Leicester water supply district, bought of Joseph Murdock.

The Board has also considered your application for advice as to the best method of disposing of the sewage of the village of Leicester on this land, a portion of which has already been acquired by the district for this purpose, and has caused an examination of the locality to be made by its engineer and samples of the soil to be analyzed.

The works already constructed collect sewage from a portion of the village and convey it to a settling tank, situated upon the higher part of the disposal area, in which a portion of the suspended matter is removed by sedimentation, and, after passing through the tank, flows to two filter beds constructed last winter, having an aggregate area of 4,000 square feet. These beds were constructed of the material found upon the area, and are provided with underdrains 3½ feet beneath the surface, from which the effluent flows out upon the surface of the ground and finds its way to Rawson Brook. The settling tank is emptied from time to time and its contents discharged upon a bed prepared for the purpose, whence they are removed after drying.

The character of the soil in this region, judging from the examinations thus far made by the Board, is somewhat variable, and is, in its natural state, poorly adapted to the purification of sewage; but mechanical analyses of samples of the soil, and experience with the filters already constructed, indicate that it is feasible to purify sewage by filtration through material of this sort, if the soil is thoroughly loosened and if a sufficient area is provided to avoid operating the filters at too rapid a rate.

The results of chemical analyses of the sewage and effluent from the filters already constructed show that a large portion of the organic matter in the sewage has been removed by these filters, though the quantity of sewage applied has been much greater than the filters are capable of purifying continuously, and they will become clogged unless the quantity applied to them is reduced.

In the absence of definite knowledge as to the quantity of sewage at present produced by the village, it is not feasible to make a close estimate of the probable area of filter beds that may be required for the satisfactory purification of the sewage; but, from present information, the indications are that about half an acre of filter beds, such as those now in use, is likely to be required, with the quantity of sewage at present produced by the village, and a larger area will be needed if the quantity of sewage increases.

The Board would, therefore, advise that you prepare at least half an acre of filter beds at the present time, and that provision be made for still further enlarging the area, should it be found, upon trial, that an area

of half an acre is insufficient for the satisfactory purification of the sewage at all times, or should the quantity of sewage increase considerably over the average daily quantity that appears to have flowed from the sewer in the past six months.

The Board would also advise that it is desirable to provide a greater depth of filtering material, where possible, in the construction of future filter beds.

LEXINGTON. The committee on sewerage of the town of Lexington applied to the Board, April 5, 1897, for its advice with reference to a proposed plan of sewerage and sewage disposal for Lexington, having an outlet into the metropolitan sewerage system. The Board replied to this application as follows: —

DEC. 2, 1897.

The plan of sewerage proposed by your committee provides for a system of sewers for the main village of Lexington and East Lexington, connecting with a main sewer beginning within a few feet of the north-westerly side of Vine Brook in a private way which crosses Vine Brook near Fletcher Street, thence running in a generally south-westerly direction to Vine Street, thence in a generally southerly direction across Woburn Street to the Boston & Maine Railroad, and along the easterly side of the railroad location to a point about opposite Flint Street, thence to and through Flint Street to Massachusetts Avenue, and following Massachusetts Avenue to the Arlington town line, where the sewage is to be disposed of into the metropolitan sewerage system. The system, as at present designed, provides for the removal of the sewage from practically all of the portions of the town which are in need of sewerage facilities, or appear to be likely to need them for several years. It is understood that all storm water, and, as far as possible, ground water, is to be excluded from the sewers; and it is important that this be done, both to avoid overtaxing the sewers and to avoid the necessity of pumping an unnecessarily large quantity of sewage.

The main sewer from Vine Street to the vicinity of the junction of Pleasant Street and Massachusetts Avenue will be within the water-shed of the Arlington water supply, and several of the tributary sewers also will be within this water-shed. The construction of the tributary sewers in this water-shed and the connection of the houses with the sewers will remove such sewage which now finds its way, directly or indirectly, into the Arlington water supply; but extra precautions should be taken to prevent danger of sewage escaping from the main or tributary sewers within the Arlington water-shed. This does not seem to be a great difficulty, and can probably be accomplished by constructing the main sewer of iron with carefully made lead joints, and by constructing the tributary sewers

within the water-shed of the Arlington water supply up to a level above the top of the main sewer in a similar manner. It will also be necessary, at places where the tributary sewers within the Arlington water-shed cross brooks above the level of the water, to construct the sewers of iron pipe. Care will have to be exercised also in preventing pollution of the water supply by laborers and others employed in the construction of the sewers.

The Board concludes that the plan as a whole, with the modifications suggested, is an appropriate one for the sewerage of the town of Lexington, and the disposal of sewage in connection with the metropolitan sewerage system is the best method of disposal for the town.

Massachusetts Hospital for Consumptives and Tubercular Patients. The trustees of this hospital applied to the Board, July 9, 1896, for its advice relative to the disposal of the sewage of this institution, situated in the town of Rutland. The Board replied to this application as follows: —

June 18, 1897.

The plan proposed was to dispose of the sewage by filtration upon land in the vicinity of the hospital, but upon examination it was found that the soil of the proposed filtration area was so fine as to be unsuited to the disposal of sewage by that method, nor did it appear that there was any land better suited for the purpose in the immediate vicinity of the hospital. Moreover, the effluent from the proposed sewage-disposal area, or any area which might be selected in the immediate vicinity of the hospital, would necessarily be discharged into a tributary of the South Branch of the Nashua River, from which the water supply of the city of Boston and other cities and towns within the metropolitan water supply district is to be taken; and, considering the great desirability of avoiding the discharge of sewage or sewage effluent into any tributary of a source of public water supply, it was suggested that an examination be made, to determine whether it was feasible to dispose of the sewage outside of the water-shed of the South Branch of the Nashua River. After further investigation, an area of gravelly land was found in the valley of a small tributary of Moulton Pond, the water of which flows into the Ware River; and plans have recently been presented by you, providing for the disposal of the sewage upon an area of land in this valley, situated about a mile west of the hospital and a little less than half a mile north-east of the village of Rutland.

The plans provide for the collection of the sewage of the hospital in a receiving basin, or flush tank, situated not far from the buildings, from which the sewage will flow in a westerly direction to the filter beds, crossing the valley of a small brook just east of the filter beds by means of an inverted siphon. Before entering the receiving reservoir, or flush tank, the sewage will be screened for the removal of large substances which

might tend to clog the sewer, and provision is made for removing deposits from the screen chamber and receiving reservoir when necessary. The receiving reservoir is to have a capacity of about 6,000 gallons, and is designed to discharge its contents automatically at intervals of several hours. It is understood that the receiving reservoir and main pipe to the filter beds have already been partially constructed.

Samples of soil from test pits on the proposed filtration area show that the material varies considerably in character, but a portion of it was found to be coarse, and of excellent quality for filtration purposes. According to the plans submitted, it is proposed to prepare fourteen filter beds, having an aggregate area of somewhat more than an acre, upon the higher portion of the area, where the best material for filtration is found; and, by removing the surface soil and the strata of fine material and constructing the beds of the coarser material, the proposed filters should be capable of purifying the sewage to such a degree that the effluent will not cause a nuisance in the small stream which flows past the filter beds, unless the population of the hospital is increased considerably beyond the number now anticipated.

The Board has carefully considered the plans submitted, and concludes that the proposed place of disposing of the sewage is a suitable one under present conditions, and for the population for which the present buildings are designed; and that the proposed works, if constructed in general accordance with the plans submitted, and if properly cared for, will operate satisfactorily in disposing of the sewage of the hospital.

Massachusetts Hospital for Epileptics. The trustees of the Massachusetts Hospital for Epileptics at Monson applied to the Board, Feb. 9, 1897, for its advice relative to the proposed disposal of sewage of the institution upon land between the town road and the Quaboag River, north of the hospital, and whether the sewage might be discharged into the river in the event of the former method proving inadequate. The Board replied to this application as follows: —

May 6, 1897.

The State Board of Health received from you, on Feb. 9, 1897, an application for advice with reference to a proposed system of sewage disposal for the Massachusetts Hospital for Epileptics, situated in the town of Monson, in which you state that it is proposed to utilize the sewage from the hospital for irrigation purposes on suitable beds on the sloping ground between the town road on the north side of the buildings and the Quaboag River. You also ask whether, if this provision should be inadequate during a portion of the year, this Board would approve of discharging the sewage directly into the Quaboag River.

The Board has caused an examination of the locality to be made by one of its engineers, and has examined samples of the soil from test pits dug upon the proposed sewage-disposal area. These examinations show that the soil of this area is so fine that it is not favorable to the absorption of a large quantity of the sewage; and, while the area is a large one and the sewage might be used upon it for irrigation purposes with some advantage to the crops during the period of rapid growth of vegetation, the sewage would have to be applied with much care, to prevent its becoming offensive.

Near the foot of the sloping ground on the northerly side of this land there is a sand bank containing material which is excellently adapted to the disposal of sewage by intermittent filtration, and to which the sewage of the institution would flow by gravity. The location is a suitable one for a sewage-disposal area, and the Board would advise that you cause an investigation to be made, to determine the feasibility and probable cost of disposing of all the sewage of the institution by intermittent filtration through filter beds prepared from the coarse material found at this place. If filter beds should be constructed at this place, their situation would be such that arrangements could be made to divert sewage from the sewer leading to the filter beds and use it for the irrigation of crops on the area referred to in your application, whenever desired.

The Board will, upon application, give you further advice with reference to any plan of sewage disposal when you have the results of further investigations to present.

The trustees of this hospital again applied to the Board, June 25, 1897, for its advice relative to the sewage disposal of the hospital upon land near the Quaboag River. The Board replied to this application as follows: —

Oct. 8, 1897.

The State Board of Health received from you, on June 25, 1897, an application for advice with reference to a proposed system of sewage disposal for the Massachusetts Hospital for Epileptics at Monson; and subsequently plans were received, through your engineer, for disposing of the sewage upon filter beds having an aggregate area of about an acre, located at a sand bank near the foot of the sloping ground about 1,200 feet north of the hospital, at a place referred to in a previous communication of this Board.

The plans provide for collecting the sewage in a flush tank, to be located just below the highway north of the buildings, from which the sewage is to be discharged at intervals upon eight prepared beds at the filtration area. The plans provide for constructing the beds of the coarse material found at this place, and, under the circumstances, underdrainage will probably not be necessary.

Provision is made whereby the sewage may be diverted from the main pipe between the flush tank and filtration area, upon a considerable area of land, and used for the irrigation of crops.

The Board has caused an examination of the locality to be made by its engineers, and, having considered the proposed plans, concludes that they will provide satisfactorily for the disposal of the sewage of the population which the hospital is at present expected to contain.

MATTAPOISETT. The Board received an application from the board of health of Mattapoisett, Nov. 8, 1897, for advice relative to the disposal of the sewage of a school-house in that town by discharge into the harbor. The Board replied to this application as follows: —

JAN. 7, 1898.

The State Board of Health received from you, on November 8, a communication requesting the advice of the Board with reference to the disposal of the sewage from a school-house now being constructed in the village of Mattapoisett, in which you state that you propose to discharge the sewage into the harbor, and that the prevailing winds are such as to favor the landing of sewage on your chief bathing beach, so that you wish to provide against the possible contamination of the water along the shore for bathing.

It is understood that the school-house is expected to accommodate about three hundred children, and that it will be closed from the latter part of June until some time in September, so that during nearly all of the summer season there will be no sewage discharged into the sewer from the school-house, but that a few houses may be connected with the sewer, in addition to the school-house, and sewage from these houses will be discharged at all seasons of the year. The sewer is also to be used as a drain for the school-house lot, and will receive surface water from the streets through which it passes. The application was accompanied by plans showing the line of the proposed sewer and two points of possible discharge for the ordinary flow of sewage, one 400 feet from the shore and the other 250 feet from the shore. The plans also provide for a storm-water overflow, to be located just above high-water line of the harbor, the excess of flow during storms to be discharged at a point just beyond low water.

The Board has carefully considered the proposed plans, and has caused the locality to be examined by one of its engineers. Considering the small quantity of sewage that it is proposed to discharge into this sewer, and the fact that the school-house, from which most of the sewage will come, is to be closed during nearly all of the summer season, the best method of disposing of the sewage, for the present at least, is by discharging it untreated into the harbor. Of the two points suggested, the one being 250 feet and the other 400 feet from the shore, it may be said that the first point will

be close to a long masonry pier which extends beyond the proposed sewer outlet, and there seems to be some danger that solid matters from the sewage will tend to settle and collect in this vicinity, whereas, if the sewer is extended beyond the end of the pier, there will be a better opportunity for the dispersal of the sewage by the currents in the harbor.

The point 400 feet from the shore will be beyond the ends of the piers, and at a place where the water has such a depth that sewage will be well diluted before it can reach any shore, and the Board advises carrying the outlet at least as far as 400 feet from the shore. Should floating matters from the sewage find their way to the shore, it may be found desirable to provide a settling tank for the removal of paper and other solid matters from the sewage; but this tank can be constructed after there has been an opportunity of observing whether its use is necessary or desirable.

Metropolitan Sewerage Commission. An application was received from the Metropolitan Sewerage Commission, April 24, 1897, for the approval of the Board, under the provisions of chapter 406, Acts of 1895, as amended by chapter 80 of the Acts of 1897, of certain plans for extension of the metropolitan sewer across the Neponset River to Milton at three points: (1) At Adams Street, Lower Mills; (2) Central Avenue; and (3) at Blue Hill Avenue, Mattapan. The Board replied to this application as follows: —

May 28, 1897.

The first plan shows a sewer about 220 feet in length, extending from the Neponset valley intercepting sewer, in Baker's Court, Dorchester, through Adams Street, to and across the Neponset River to a point in Milton about 13 feet south of the face of the southerly abutment of the Neponset River bridge, and just beyond a man-hole to be located close to the southerly end of the bridge. This sewer is designed to intercept sewage from an existing sewer in Milton Lower Mills, which now discharges into the Neponset River below the last dam. By the plan submitted, the proposed extension in crossing the Neponset River will be attached to or suspended from the existing bridge.

The plan also shows the method suggested for the connection of the Milton sewer with the metropolitan sewer, involving an inverted siphon, consisting of two 6-inch iron pipes, to convey the sewage beneath the New York, New Haven & Hartford Railroad. In order to secure a greater certainty of the successful operation of the siphon, it is desirable that the pipes be larger or that ordinary sewer pipes be used instead of iron.

The second plan shows a sewer about 250 feet in length, extending from the Neponset valley intercepting sewer, in Central Avenue, Dorchester, to and across the Neponset River to a proposed man-hole on the Milton

side of the river, about 10 feet from the southerly end of the Central Avenue bridge. It is proposed to support the sewer upon a portion of the bridge structure where it crosses the river.

The third plan shows a sewer about 195 feet in length, extending from the Neponset valley intercepting sewer, at Mattapan Square, to and beneath the Neponset River to a point in Milton about 30 feet south of the southerly bank of the river. The place of crossing the river, as indicated by the plan, is about 18 feet east of the present Blue Hill Avenue bridge.

The proposed extensions of the Neponset valley sewer in Central Avenue and Blue Hill Avenue are designed to receive sewage from districts in Milton indicated upon a plan submitted to this Board in 1894 by a sewerage committee of the town of Milton, and approved by the Board Sept. 25, 1894. The proposed extension in Adams Street is designed to receive the dry-weather flow from an existing sewer in the village of Milton Lower Mills. This sewer, it is understood, receives at present both sewage and storm water; but the proposed extension of the Neponset valley sewer is designed to receive only the dry-weather flow from this sewer, allowing the surplus, at times of storms or melting snows, to be discharged into the Neponset River, below the last dam, as at present.

The Board has caused an examination of the location, sizes and grades of the proposed extensions to be made by its engineer, and concludes that they are adapted for the removal of the sewage which it is designed to convey to them, and that, if constructed with care, and if the sewers crossing the river at Adams Street and Central Avenue are attached to and supported by the bridges in such a manner that they may not receive injury from freshets or otherwise, they can be made to operate satisfactorily.

The Board hereby approves the proposed extensions of the Neponset valley sewer in Adams Street, Central Avenue and near Blue Hill Avenue, as described herein.

METROPOLITAN SEWERAGE COMMISSION. The commission applied to the Board, March 16, 1897, for its advice relative to the question of constructing overflows in the Neponset valley sewer at certain points indicated, in the valley between Dorchester and Milton. The Board replied to this application as follows: —

JULY 1, 1897.

The State Board of Health received from you, on March 16, 1897, an application requesting its advice with reference to and its approval of a proposed connection with the Neponset valley intercepting sewer of a branch sewer in Dorchester which it is proposed to connect with the intercepting sewer in River Street, in Dorchester, at a point about 100 feet north of Fremont Street.

You state that the system to be connected with the Neponset intercepting sewer is to be constructed strictly upon the so-called "separate" plan,

excluding surface and roof water; and that it is your purpose to require at this connection an automatic overflow, so designed as to act only when the intercepting sewer is filled to its maximum flow line. You also state: —

This is the first application that has been filed for a connection in the Neponset valley. The commissioners desire to approve a connection at this point, the details of which can be consistently followed in other connections throughout this area. It is estimated that the cities and towns tributary to this intercepting sewer may in the future possibly have two hundred miles of local sewers connected with the metropolitan sewer. The commissioners are of the opinion that it would be unsafe and unwise to connect so great a length of lateral sewers to an intercepter without overflows, if the lateral connections should not be provided with automatic reliefs to act in case of the shutting down of pumps at the pumping stations, or in case of obstruction to the main sewer from any other unknown or unforeseen contingency.

The sewage from the upper areas in this valley is collected at elevations sufficient to discharge sewage from the upper cities and towns upon the surface of the streets in the lower areas through man-holes, in case of obstruction to the main sewer above tide water, unless some provision is made for diverting it into natural water courses.

The application was accompanied by plans showing the area for which the proposed branch sewer is to provide, and details of construction of the proposed connection and overflow.

The Board has carefully considered your application, and the plans submitted, in connection with the general plan of sewerage of the Neponset valley and the main drainage system of the city of Boston, and is unable to see how the shutting down of the pumps at the Boston main drainage pumping station, which is the only pumping station connected with these systems below the Neponset valley intercepting sewer, can have the effect of surcharging the Neponset valley sewer in the vicinity of the proposed connection in Dorchester, since provision is made whereby the Dorchester intercepting sewer, into which the Neponset valley sewer discharges, is automatically disconnected from the Boston main drainage sewer when the sewage in the latter rises above a certain height, and the sewage of the Dorchester sewer may discharge through overflows into tide water. Moreover, as stated in the reply of the Board last year, in reference to overflows from the Neponset valley sewer, the information furnished by experience in the operation of separate systems of sewerage in this State has been that the necessity for automatic overflows has not arisen.

Sewage discharged from the overflow proposed in your application would enter the fresh-water portion of the Neponset River in the midst of a residential district, where the river has a very sluggish current most of the time, owing to a dam a short distance below.

The Board believes it to be important to keep sewage from entering the fresh-water portion of the river, on which there are several dams, and that no opportunity should be afforded for the disposal of any sewage in this

way unless it may be absolutely necessary in order to prevent the danger of a greater nuisance elsewhere. It does not appear to the Board that it is necessary to provide an automatic overflow for the proposed connection with the intercepting sewer in Dorchester, and the Board therefore does not approve the construction of an automatic overflow at this place.

The Board would repeat its statement made in a previous reply relative to this subject, that there may possibly be points in the Neponset valley system not known to this Board where unusual emergencies may occur, and where safety would require an outlet gate which can be opened temporarily, and if such points are found to exist, this Board will consider plans you may present in regard to them; but the Board is desirous of avoiding the discharge of sewage into the Neponset River above any of the mill dams, when not absolutely necessary.

MOUNT HOLYOKE COLLEGE. The trustees of Mount Holyoke College, in South Hadley, applied to the Board, April 9, 1897, for its advice relative to certain alternative methods of disposing of the sewage of the college. To this application the Board replied as follows: —

MAY 6, 1897.

The State Board of Health received from you, on April 9, 1897, an application for advice with reference to the disposal of the sewage of Mount Holyoke College, in the village of South Hadley, containing an outline of the plans under consideration for the disposal of the sewage, as follows: —

The disposal of sewage from Mount Holyoke College is to be undertaken to prevent the contamination of the brook which flows through the grounds, and from there down through the town of South Hadley, eventually emptying into the Connecticut River. There have been three plans proposed, viz., running the sewage into large settling tanks, in which precipitation was to be effected either naturally or by chemicals, the effluent to be run from these tanks into the stream, the sludge being disposed upon a comparatively small filtering bed, where it was to be allowed to drain and then removed in wagons.

The second scheme was to utilize a sand-filtering bed of about one-half acre area, first running the sewage into a small settling tank, where the solids would be deposited, and from there running the sewage on to this filtering bed, conducting the effluent through underdrains into the stream. The preferable plan, in our judgment, would be to have as small a filtering bed as possible, running the sewage first into the settling tank and then on to this filtering bed. We understand if such a bed was composed of coke breeze, about 6 feet thick, we could dispose of at least 500,000 gallons per day to the acre. At the college we will need to dispose of about 30,000 gallons per day, this being about the amount of water that is pumped to the institution. Under these conditions it would appear that we would need to have from 1,200 to 1,400 square feet filtering area, and, if it were not a larger area than this, it could be covered, thus preventing its freezing in winter and also hiding it from view.

The Board has caused an examination of the locality to be made by one of its engineers, and has carefully considered the proposed plans. It is understood that by either of the plans suggested it is proposed to locate the sewage-disposal works just below the small pond formed by a dam on a brook which flows through the college grounds on the westerly side of the buildings, and that a sewer has been constructed a portion of the distance from the college to this place.

The first plan suggested is to discharge the sewage into large settling tanks, with a view to removing a portion of the organic matter by sedimentation or chemical precipitation, and to allow the effluent to flow from the tanks into the brook. It is proposed, also, to discharge the sludge from the tanks upon a small filter bed, upon which it will be allowed to dry and then be removed in carts. By this plan a considerable portion of the solid matters could be removed from the sewage; but at best it is not to be expected that more than half of the organic matter would be removed by this process, and the effluent would still be of such a character as to seriously pollute the brook during the drier portion of the year. Moreover, the process of drying and removing the sludge from the filter bed would be very likely to cause offensive odors in the neighborhood.

By the second scheme it is proposed to filter the sewage through a prepared bed of sand after it has passed through a settling tank for the purpose of removing the heavier solids; and by the third scheme, which you consider the preferable one, it is proposed to use a coke filter bed 6 feet in depth instead of the sand filter bed.

By either of these two schemes, with a sufficient area of filters, the sewage could be purified to such a degree that the effluent would not cause offence if discharged into the stream; but the character of the soil at the place where it is proposed to locate the filter bed is not favorable to the purification of sewage, being composed of very fine material, such as loam or clay, so that it would be necessary to haul the filtering materials, whether sand or coke, to this place, which would make the disposal of the sewage by either of these plans very expensive. Moreover, the works would be situated near the college grounds, and much care would be required in their management to prevent odors from being noticed in the vicinity.

From a general examination of the land about the college, there appear to be two places where it may be possible to dispose of the sewage by filtration at a greater distance from the college buildings and from other houses, and possibly at less expense than at the place where you now propose to locate the works. One of these is on the easterly side of the brook and south of Prospect Hill, where there is a considerable area of sandy land, a portion of which may possibly be reached by gravity.

Another and apparently a more favorable location, in some respects, is in the valley of a small brook on the westerly side of the college grounds,

where the soil is of a sandy nature and suitable for the purification of the sewage by filtration.

It is not feasible to tell, from the limited examinations made by the Board, whether either of these areas is available for the disposal of the sewage of the college, or whether there may not also be other areas within a reasonable distance that are adapted to the purpose. It is desirable to locate the works, if possible, at a greater distance from the college or other human habitations than is proposed in the plans suggested by you, and it is probable that, if a suitable area can be secured, the sewage could be disposed of upon it by intermittent filtration at less cost than by either of the filters proposed in your application.

In view of these conditions, the Board does not at present advise the disposal of the sewage of the college by either of the plans suggested in your application, but advises a further investigation, to determine whether there is not some suitable area of land upon which it may be feasible to dispose of the sewage by intermittent filtration at a reasonable cost. If one or more such areas be found, a careful estimate should be made of the probable cost of disposing of the sewage upon them.

The Board will assist you in these investigations by making examinations of filtering materials, and will upon application give you further advice in this matter when you have the results of further investigations to present.

Another application was received from the trustees, June 22, 1897, submitting a proposed plan for the sewage disposal of the college, to which the Board replied as follows: —

Dec. 2, 1897.

The State Board of Health received from you, on June 22, an application for advice with reference to a proposed system of sewage disposal for Mount Holyoke College, in which you describe your proposed plan as follows: —

I enclose you a blue print of a filter bed which we propose to use at Mount Holyoke College for the disposal of the sewage from the institution. You will see by the plans that we intend to bring the sewage in at the end of the filter bed into a small basin which contains screens for the removal of foreign substances. It is proposed to so arrange these screens that they may be lifted out for cleaning purposes. After the sewage passes through the screens, it will flow into a trough which will distribute it over the area of the filter bed. It is proposed to make these troughs of cast iron, so that they will be durable, unless you think they could be made of wood satisfactorily. We propose putting about 8 inches of coarse rock at the bottom of the filter bed, then about 8 inches coarse coke, and then filling the rest of the space with coke breeze. We have provided a by-pass from the sewer entrance to the bed, so that the sewage may run around the filter bed direct to the brook, if at any time it is necessary, or when there is a large enough flow of water in the brook to carry it away satisfactorily.

It seems to us that this plan, with what modifications you may deem advisable, will be best for the location, as it is impossible to get the sewage to any natural sand filter bed except by mechanical means, which, in our opinion, will be more expensive to maintain and to run than the proposed bed. We have thought that this bed would not be at all objectionable, as it is some 600 feet away from the nearest building, and it is proposed to cover it.

We propose to cover the main drains underneath the bed with cast-iron plates, perforated. I estimate the cost of this bed at about $2,600, and it seems to me that we cannot make anything which will be less expensive and as effective. I do not think that we will at any time have more than 15,000 gallons of sewage to dispose of per day, and this amount will be distributed over a period of time from five o'clock in the morning to ten o'clock at night. We propose to lay all brick work in cement, so that it will be water tight, and to thoroughly cement the bottom over the brick.

The application was accompanied by plans of the grounds and of the proposed filter beds.

The Board has carefully considered your application, and concludes that, if the quantity of sewage does not average more than 15,000 gallons per day, it would be possible to purify it by the proposed filter. and by avoiding the use of a sludge tank there would be less danger of odors being noticed in the vicinity of the works than by the former plan submitted by you; but a successful purification of the sewage would be more certain, and less care would be required to secure satisfactory results, if a larger area of filter beds should be used. It is not improbable, however, that the quantity of sewage may be considerably larger than 15,000 gallons per day; and, if this should be found to be the case, a larger filter bed would be necessary. It is very desirable that the filters be made of sufficient size in the beginning to purify all of the sewage of the college at all times, and no unpurified sewage should be discharged into the brook.

In the previous reply of the Board with reference to this subject you were advised to investigate the practicability of disposing of the sewage by filtration upon land; and investigations made by you, subsequent to the time of filing the present application, indicate that it is practicable to convey the sewage by gravity to the valley of a small brook west of the college grounds, in which sandy soil is found, suitable for the disposal of sewage by intermittent filtration. Moreover, your investigations indicate that the cost of conveying the sewage to this valley and constructing disposal works there might be less than the cost of construction of the works you now propose, and it is also probable that a satisfactory operation of the filters would be secured with less care and expense. While the college does not own land in this valley that might be used for sewage-disposal purposes, it seems probable that land might be acquired here at a reasonable cost, so situated that there should be no objection to its use for the purposes proposed.

In view of all the circumstances, the Board would advise that you investigate more thoroughly the feasibility of obtaining a suitable area of land in this valley for the disposal of the sewage of the college. The Board will, if you desire, give you further advice in the matter should you decide to change your present plans.

NATICK (The Leonard Morse Hospital). The trustees of this hospital applied to the Board for its advice relative to the disposal of the sewage of the hospital. The Board replied to this application as follows: —

JULY 1, 1897.

The State Board of Health received from you, on May 11, 1897, an application for advice with reference to the disposal of the sewage of the Leonard Morse Hospital, in which you state that it is proposed to carry the drainage from the hospital to three tight cesspools. It is assumed that the sewage on leaving the third cesspool will be quite free from solid matter, and it will then flow into a trench 75 feet long, filled at the bottom with stone and above with earth.

The Board has caused an examination of the locality in which you propose to dispose of the sewage to be made by one of its engineers, from which it appears that the soil at this place is composed of clayey material nearly impervious to water, and that ledge is found about four feet below the surface. With these conditions it will not be practicable, in the opinion of the Board, to dispose of the sewage of the hospital at this place in the manner proposed. Moreover, from a general examination of the territory about the hospital, it does not appear that there is any land suitable for sewage disposal purposes within a reasonable distance.

The town of Natick, in which the hospital is situated, is provided with a system of sewers; and the Board is informed that the hospital is so situated that it is feasible to dispose of the sewage into the Natick system by means of a sewer to connect with one of the sewers already built in the town, or with an extension of this sewer.

Under the circumstances, the Board is of the opinion that the best method of disposing of the sewage of this hospital is by discharging it into the sewerage system of the town of Natick.

NORTH ADAMS. The board of health of North Adams requested the opinion of the State Board of Health, Oct. 23, 1896, in relation to the advisability of constructing a sewer about 3,000 feet in length through a certain district upon the border of the north branch of the Hoosac River. The Board replied to this application as follows: —

Nov. 4, 1897.

The State Board of Health received from you, in October, 1896, an application for advice as to the advisability of constructing certain proposed intercepting sewers to divert sewage from the north branch of the Hoosac River in North Adams, in order to improve the condition of the river.

At the time the application was made the flow of the stream had risen much above its summer flow, and further investigation of the matter was postponed until a low flow in the stream could be observed. Owing to the unusual rainfall of the spring and summer, the flow in the streams was high until lately; but it appears that in the meantime the city has begun the construction of the intercepting sewers, concerning which advice was asked, so that under the circumstances no further investigation appears to be necessary with reference to this matter.

Quincy. The sewer commissioners of Quincy applied to the Board, Sept. 4, 1896, for its advice in relation to a general system of sewerage and sewage disposal for Quincy, the sewage to be discharged into the Boston main drainage system at Squantum. The plans of the system were revised and presented to the Board Dec. 4, 1896, and further amendments were presented Dec. 30, 1896. The Board replied to this application as follows: —

Jan. 22, 1897.

The State Board of Health received from you, on Sept. 4, 1896, a plan for a proposed system of sewerage, accompanied by a general description of the proposed system and a report of your consulting engineer. At a later date, Dec. 4, 1896, a revised plan was submitted through your engineer, accompanied by the following statement: —

I submit herewith additional information concerning the proposed sewerage system for the city of Quincy. The accompanying plan shows areas to be drained by the system, together with the location and size of the intercepting sewers and the force-main.

Drainage areas Nos. 1 to 7 will drain by gravity into the mains as shown, thence to pumping station, from whence the sewage will be pumped to the outfall sewer of the Boston main drainage works at Squantum. Area No. 10 will drain by gravity into the Boston outfall sewer. Areas Nos. 8 and 9 may be provided for by independent gravity systems, discharging directly into tide water. As outfalls adjacent to these sections have already been approved by the State Board of Health as points of discharge for the whole of Quincy's sewage, it is thought that there will be no objection to these independent gravity systems for such small sections.

There remain, not included in the areas mentioned above, an area at Quincy Point and one on the north side of Atlantic village. Both of these areas are of small extent, and it is thought that their development will be slow. They can be

drained by automatic pumping plants worked by electric or gas engines, which will discharge into the Quincy mains, or, if it should seem advisable, may be furnished with independent tidal outlets. The areas being so small, there is little probability of their becoming a nuisance.

Three temporary overflows are shown on the plan, the one located on the line of the intercepting sewer at the canal, another where it crosses Black's Creek, the other near the pumping station, emptying through an open ditch into Black's Creek. In the force-main three blow-offs are shown, one discharging into Sachem's Brook, the other two into tide water.

Other features of the system are as shown on the plan and description previously submitted.

You subsequently requested that areas numbered 8 and 9 on the plan, comprising the peninsula containing the villages of Hough's Neck and Germantown, be omitted from consideration, stating that it was not proposed to provide sewers for these areas at present, and that, when the details of a plan for the disposal of the sewage of these localities has been decided upon, it will be submitted to the State Board of Health for approval.

The Board has carefully considered the proposed plan, and has caused an examination of the territory to be made by its engineer. The plan provides for a system of intercepting sewers to collect the sewage from the various villages in Quincy and convey it to a proposed pumping station to be located on the north-easterly side of Merry Mount Park. From the pumping station the sewage is to be forced through an iron force-main and discharged into the Boston main drainage sewer at Squantum.

Aside from areas numbered 8 and 9 on the plan, which are omitted from consideration at the present time, the proposed intercepting sewers provide for taking the sewage from all portions of the city that are likely to need sewerage for many years. Small areas in the northerly and southerly parts of the city and a considerable portion of the low land in Squantum cannot be served by the proposed sewers; but these areas are chiefly marsh lands, and are largely unfit for human habitation, and there is no present indication that they are likely to require sewerage facilities for many years. Such districts have been protected in communities about Boston by the establishment of minimum grades for streets and cellars below which no building from which sewage might be discharged should be constructed; so that it seems proper to omit them from consideration at the present time, rather than to go to the expense of providing for their sewerage in connection with the proposed system in the beginning.

In order to collect all of the sewage at one pumping station, it is necessary that it be centrally located, and the location selected is such that it will be at a considerable distance from dwelling-houses, in the beginning at least; but its proximity to the park will make it necessary, in order that there may be no odor from it in the neighborhood, to make provision

for the thorough ventilation into the chimney of the sewers, screen chambers and pump well, and any other places from which an odor of sewage might escape. It is understood that these matters have been carefully considered, and that all screening is to be done inside of the pumping station. With proper care in the design and construction of the station, no odor of sewage need ever be noticed from it in the neighborhood.

In the plans submitted three overflows are provided, — one at the pumping station, one into Black's Creek and one into Town River. It is understood that these overflows are only for use temporarily, in case of emergency; and that they are not to be automatic, but are to be provided with gates, which can be raised should an emergency arise requiring their use. In a system like this it is essential that some provision be made whereby the sewage can be disposed of should an accident occur to the pumping station or force-main. The overflows into Black's Creek and Town River appear to be the best that it is practicable to select. The overflow at the pumping station would discharge into a very small ditch; and, while it is desirable that an overflow be provided at this point, it would be better, in case it becomes necessary to discharge sewage from the mains, that it be discharged at either of the other points rather than at this one.

The provision for blow-offs on the force-main is also necessary, and these blow-offs appear to have been selected at the best practicable points. They must be considered, of course, only as provisions for unforeseen emergencies, and not for frequent or regular use.

The plan as a whole will make satisfactory provision for the sewerage of the city of Quincy, and, in accordance with the provisions of chapter 279 of the Acts of 1895, is hereby approved.

SOUTHBRIDGE. The committee on sewerage of the town of Southbridge applied to the Board, Nov. 3, 1897, for its advice relative to a proposed system of sewerage and sewage disposal for that town. The Board replied to this application as follows: —

JAN. 7, 1898.

The State Board of Health received from you, on Nov. 3, 1897, an application for advice with reference to a proposed sewerage system for the town of Southbridge, in which you state that you propose to bring the sewage of the town to a point in Main Street a short distance east of Morris Street and thence across the Quinebaug River at the "old dam," so called, and to dispose of the sewage on filter beds on the northerly side of said river. You also state that you except from this system about 3,200 feet of the lower portion of Main Street, ending at Saundersdale; and you suggest the disposal of the sewage of this portion of the town either upon a separate area or by direct discharge into the Quinebaug River, near the bridge in Saundersdale.

The application was accompanied by a plan showing a general system of sewerage for the town. Two filtration areas are indicated upon this plan, — one on the northerly side of the river, a short distance below the dam of the American Optical Company, and the other on the same side of the river, in the valley of Dean Brook. Subsequently, after further examination, you submitted a topographical plan of the filtration areas referred to.

The Board has caused the locality to be examined by one of its engineers, and has carefully considered the proposed plan. The system of sewers proposed for Globe Village and Southbridge Center appears to provide satisfactorily for the collection of the sewage of these villages and for conveying it by gravity to either of the two filtration areas referred to above. At the upper filtration area indicated upon the plan there is a flat strip of land lying between the river and the base of a steep hill, having a general width of about 400 feet and an area of about 15 acres. It appears that a large portion of this area is but slightly above the level of high water in the river, though some portions of it are higher; and in the higher places the material, as indicated by a few test pits, appears to be of a very coarse sand, well suited for the disposal of sewage by intermittent filtration. A short distance north-west of the upper end of this area, in the vicinity of the dam of the American Optical Company, there is an area at a considerably higher elevation, which is composed apparently of coarse sand or gravel, from which it is proposed to take material to construct filter beds upon the area already referred to near the river. If sufficient material can be obtained at the place referred to, it appears to be practicable to construct 15 acres of filter beds upon this area; and an area of this size would provide satisfactorily for the disposal of the sewage of the town for a considerable number of years in the future, but the cost of constructing beds in this way would be large.

It is understood that you propose, when the filter beds at this place shall have become insufficient for the disposal of the sewage of the town, to extend the sewer to the valley of Dean Brook about 4,500 feet below the works of the American Optical Company and 2,500 feet below the lower end of the upper filtration area. A general examination of this land shows that there is an area of about 7 acres at such an elevation that sewage from the town could be discharged upon it by gravity, and it is at a sufficient elevation to make it practicable to use the land for the filtration of sewage by lowering somewhat the bed of the brook.

In addition to this area there appears to be an area of 11 acres which is quite low, and which it is proposed to utilize by filling with material to be taken from a sandy ridge in the vicinity; and it will probably be practicable to prepare in all an area of 20 acres for filter beds in this locality, if there is sufficient material available in the sandy ridge. Samples of soil collected from a limited number of test pits on the area of 7 acres which

can be used without much preparation and from the sandy ridge referred to indicate that the soil is probably of good quality for filtration purposes. The advantage of using the upper filtration area is thought to be its nearness to the town; but after careful consideration of the plans, the Board is of the opinion that it may be found considerably less expensive for the town to abandon the plan of utilizing the upper area, and extend its sewer in the first place to the lower filtration area, since the cost of preparing filter beds at the latter place will probably be enough less than the cost of preparing beds at the upper location to more than make up for the additional length of sewer. Moreover, the lower filtration area is more remote from the thickly settled portion of the town; and, as the population is increasing with considerable rapidity, it seems desirable to locate the filter beds at a greater distance from the main village, if practicable, than the proposed upper area. It seems necessary to omit from this plan the village of Saundersdale, which is at so low a level that the sewage cannot be collected and conveyed to either of the proposed disposal areas without pumping. While the disposal of the sewage of the very small population contained in this village by discharging it directly into the river might be permissible for the present, at least, it is very desirable, before finally deciding upon this method, to determine whether it may not be practicable to purify the sewage by filtration before discharging it into the river.

In the opinion of the Board, the proposed plan of collecting the sewage in a system of sewers from which all storm and ground water is excluded so far as practicable, and disposing of it by filtration upon land, is the best method of disposing of the sewage of Southbridge; and the area suggested by you in the valley of Dean Brook appears to be, all things considered, the best available area for the purpose; but the Board would advise, before beginning to construct works, that a more thorough investigation be made at both filtration areas, to determine more accurately the character of the soil and whether there is sufficient suitable soil available for the construction of beds of sufficient area for the disposal of all the sewage of the town for a reasonable time in the future.

The Board will assist you in this matter by making such examinations of samples of soil as may be necessary, and will give you further advice when you have the results of further investigations to present, and have prepared plans in detail for the disposal of the sewage upon the area which is found to be the most satisfactory for the purpose.

SPENCER. An application was received from the selectmen of Spencer for the advice and approval of the State Board of Health with reference to the taking of a certain lot of land for sewage disposal, situated near the main road leading from Spencer to Brookfield. A hearing was held at the office of the Board July 1, 1897,

at which the towns of Spencer and Brookfield were represented. Objection was made to the location, and another plan and location were presented for a lot situated south of Main Street and west of the South Spencer Road. The Board approved the location and sent the following reply to the selectmen of Spencer: —

JULY 15, 1897.

On the first day of July, 1897, upon a public hearing and after consideration, the State Board of Health voted to approve the purchasing or taking by the town of Spencer of land situated south of Main Street and west of the South Spencer Road in that town, as shown upon a plan submitted July 1, 1897, by the authorities of the town of Spencer, for the purification and disposal of sewage, the said land being bounded, measured and described as follows: —

First Tract. — A certain tract of land, situated in the westerly part of said Spencer, owned by Joshua Bemis, and bounded as follows: beginning at a north-easterly corner thereof, on said Main Street, thence south 8¼° east, by land of the J. W. Wilbur Company, about 19 rods and 9 links; thence south 11° west 32 rods and 17 links; thence south 81° east about 14 rods and 5 links to the road leading to South Spencer, all of the aforesaid courses being by land of the said J. W. Wilbur Company; thence southerly, by said South Spencer Road, about 37 rods to land now or formerly of Mrs. Samuel Warwick; thence westerly about 8 rods and 17 links; thence south 28¼° west about 22 rods to the mill-pond, owned by Dufton Brothers, the last two courses being by land of said Warwick; thence westerly by said mill-pond about 50 rods to land of Lucretia H. Upham; thence northerly by land of said Upham, said mill-pond and other land of said Dufton Brothers to the aforesaid Main Street; thence easterly by said Main Street about 33 rods to the place of beginning, containing about 17 acres.

Second Tract. — A certain tract of land, now or formerly owned by Mrs. Samuel Warwick, situated south-easterly of and adjoining the above-described tract, with buildings thereon, and bounded as follows: beginning at the north-easterly corner thereof, on the westerly side of the road leading to South Spencer; thence westerly, by land of Joshua Bemis, about 8 rods and 17 links; thence south 28½° west, by land of said Bemis, about 22 rods to the mill-pond; thence easterly, by said pond, about 17 rods to the old road; thence northerly, by said old road and the present road to South Spencer, about 34 rods to the place of beginning, containing about 2½ acres.

Third Tract. — Two certain small tracts of land owned by Lucretia H. Upham, situated westerly of and adjoining the first-described tract, and bounded as follows: easterly by land of said Bemis; and southerly, westerly and northerly by the aforesaid mill-pond, owned by Dufton Brothers, containing, respectively, about 1½ and 1¼ acres.

The plan for the disposal of the sewage of the town of Spencer upon this land contemplates the removal of the connections by which storm water is now admitted to the sewers of the town, and the diversion of the sewage

from the present main sewer to the filtration area through an iron pipe 10 inches in diameter and about 3,100 feet in length, laid in the form of an inverted siphon. Provision is made for screening the sewage before it enters the pipe, which, at its upper end, will be at an elevation of about 15 feet above the point of discharge at the filter beds. At a low point in this siphon, not far from the place where it leaves the main sewer, it is proposed to provide a blow-off, in order to empty the pipe when necessary. Sewage withdrawn from the pipe at this place is to be disposed of by filtration upon a filter bed to be built upon a lot of land owned by the town near the junction of Main and Meadow streets, known as the town lot. Another depression in the pipe occurs near the proposed filtration area upon land which you now propose to take, and it is proposed to dispose of the sewage from this blow-off, whenever it may be opened, upon a bed to be prepared for the purpose.

At the filtration area the plans provide for the preparation of 15 filter beds, having an aggregate area of 10 acres. Some of the beds will have an elevation of only about 6 feet above high water in the Seven-mile River, and these beds are to be provided with underdrains, while beds upon the higher portion of the area will be constructed without underdrains.

The Board has carefully considered this plan, and concludes that, in general, it will provide satisfactorily for the disposal of the sewage of the portion of the town of Spencer which is now provided with sewers discharging into the Seven-mile River near the town lot, so called, if the present connections by which storm water is admitted to the sewers are removed, and if care is taken, in making future extensions to and connections with the sewers, to prevent the entrance of storm or ground water.

It is very desirable to screen the sewage, as proposed, before it enters the siphon, in order to prevent the entrance of large substances which might tend to clog the siphon, and, by providing a very large screen area, excessive care of the screens will be avoided.

Judging from information furnished by you as to the probable quantity of sewage that will flow in the main sewer after the storm-water connections have been removed, the capacity of the iron pipe, of which it is proposed to construct the siphon, is sufficient with the available head to carry all of the sewage flowing in the sewer to the filtration area, even should the carrying capacity of the pipe be reduced by tuberculation, or fouling on the inside, as it may be after a longer or shorter period of use; but if a considerable reduction in the capacity of the pipe should take place from this cause, and there should also be a material increase in the population of the town and in the quantity of sewage discharged into the sewers in the future, the capacity of the siphon might not be sufficient to remove the whole flow of sewage at all times. The capacity of the siphon could be materially increased by laying a larger pipe in the beginning without greatly increasing the cost of the works; and, in view of all the circumstances, the

Board would advise that a pipe of somewhat larger diameter be used in the construction of the works.

The material of the proposed filtration area is of excellent quality for the filtration of sewage, and the water level in the ground is apparently at such a distance below its surface that beds upon the higher portions of the area will not require underdrainage. The area which it is proposed to prepare in the beginning is ample for the present needs of the town, if storm water is excluded from the sewers, and it is practicable to enlarge the area considerably by the construction of other beds if it becomes necessary. The effluent will be discharged into the Seven-mile River, and, if the beds are carefully constructed with underdrainage where necessary and receive proper attention, the disposal of sewage at this place in the manner proposed will not have an unfavorable effect upon the appearance or odor of the stream.

The present plan does not provide for taking the sewage from the sewer which now discharges into the Seven-mile River near Pleasant Street; and, while a thorough investigation of the best method of disposing of this sewage has not been made, the indications are that it can be purified on land in the vicinity of the outlet, and at a less cost than by constructing a sewer to connect this system with the system which serves the greater portion of the town.

Taunton. A plan for the sewerage of the city of Taunton and for the disposal of the sewage on land in Berkley on the Assonet Neck Road was presented to the Board by the sewer commissioners, April 30, 1897.

In compliance with the provisions of chapter 268 of the Acts of 1897, a hearing was held at the office of the Board, on July 15, 1897, with reference to the proposed method of sewage disposal of Taunton. A letter was received by the Board from the counsel of the town of Berkley, stating that "The town of Berkley is entirely satisfied with the statute of 1897 regarding Taunton sewerage. They do not desire to be any further heard in the matter." And the following reply was sent to the sewer commissioners on the same day: —

The State Board of Health received from you, on April 30, 1897, the following application, requesting the approval by the Board of a plan of sewerage and sewage disposal for the city of Taunton: —

We herewith submit to you a plan for a system of sewers and sewage disposal for the city of Taunton, Mass., as provided in chapter 219 of the Acts of 1895, and also in the act to authorize the city of Taunton to extend its system of sewerage. . . . being chapter 268 of the Acts of 1897.

A general description of this plan is to conduct all of the sewage to a place just below the corner of West Water and Fifth streets, to build a reservoir and pumping station there, and to force the sewage to land in Berkley on Assonet Neck Road, so called, and there treat it by downward filtration through sand. Samples of the sand from this field have been submitted to your engineer for examination.

We propose to follow the plan designed by Luther Dean, city engineer, and described by him in his report to us, dated Jan. 28, 1897. A copy of said report accompanies, and is made a part of, this petition.

We hereby submit this plan, as described in this report, to you for your consideration, and if it meets with your approval, request your permission to build said system of sewers and sewage disposal.

The report of the city engineer, dated Jan. 28, 1897, referred to in the above application, contains the following outline of the proposed plans of sewerage and sewage disposal: —

The general plan is, then, to collect all of the sewage at Taunton River, just below Fifth Street, to build a covered reservoir here for the proper collection of this sewage, to build a pumping station here, and to force the sewage to the land on the Assonet Neck Road, and there treat it by downward filtration through sand. In my opinion, the main trunk sewer could be safely emptied into the river at this point during construction, so that the pumping station, force-main and filter-beds need not be built until later.

The accompanying plans show contours on the Berkley field, the location of the field and the approximate location of the force-main, the location of the trunk sewers and the boundaries of the drainage areas served by them. The sizes and grades for proposed trunk sewers are shown on accompanying profiles.

The land which it is proposed to use for sewage disposal on the Assonet Neck Road is shown upon a plan made by Luther Dean, city engineer, and filed with this Board, June 1, 1897, and is more particularly described in a communication signed by your Board, dated June 16, 1897. In this communication you also add: —

The proposed plan includes as an essential feature that all sewage from the sections of Taunton on the westerly side of Taunton River shown upon the "map of a section of the city of Taunton for proposed sewerage system, Luther Dean, city engineer, 1897," filed with this petition, shall be disposed upon this land on or before the first day of July, 1902.

In accordance with the provisions of chapter 219 of the Acts of 1895 and of chapter 268 of the Acts of 1897, a hearing was given by the State Board of Health at its office on July 15, 1897, after notice by the Board of the presentation to it of the proposed sewerage system for its approval, by publication of such notice in two daily papers and one weekly paper in the city of Taunton, and by official notice, in writing, to the selectmen of the town of Berkley.

The State Board of Health, having considered the proposed plan of

sewerage and sewage disposal for the city of Taunton as presented by the sewer commissioners of said city, and as modified by them in their communication dated June 16, 1897, approves the proposed system as so modified, and the proposed location of the sewage-disposal works; an essential part and feature of the system hereby approved being that all sewage from these sections of said city on the westerly side of the Taunton River, shown upon the map entitled, "Map of a section of the city of Taunton for proposed sewerage system, Luther Dean, city engineer, 1897," filed with the petition of said commissioners, shall be disposed of upon land upon the Assonet Neck Road described in the above communication from said commissioners to said State Board of Health, dated June 16, 1897, on or before the first day of July, A.D. 1902.

The proposed system is designed to take sewage only, and it is proposed to construct underdrains beneath the sewers to remove ground water and to reduce the leakage of ground water into the sewers. It is very desirable, where all of the sewage must be pumped and purified, that the quantity should be as small as possible; and, if the system is thoroughly constructed in the manner proposed, the main trunk sewers will provide for the removal of the sewage of the districts which they are designed to serve.

The proposed pumping station is located in the vicinity of a considerable population, but the best practicable location seems to be in this immediate neighborhood. On account of its proximity to houses, it will be necessary, in order that there may be no odor from it, to make provision by connection with the chimney of the boiler house for the thorough ventilation of the sewers, screen chambers, pump well and reservoir, and any other places from which an odor of sewage might escape; and, with proper care in the design and construction of the station, no odor need ever be noticed from it in the vicinity.

It is proposed to construct a covered reservoir at the pumping station to receive the night flow of sewage, and to pump the sewage during working hours through a twenty-inch force-main to the proposed disposal area near the Assonet Neck Road. During the first few years of the operation of the works it may be feasible, with a small reservoir, to pump all of the sewage in the day-time, and with a small quantity of sewage this method would probably be the most economical; but with the extension of the system the quantity of sewage is likely before many years to become so large that the economy of pumping through a larger main would more than offset the extra cost of the construction of a larger main in the beginning.

The plans provide for an overflow at the pumping station to waste the sewage in case of necessity into the river; and in a system like this it is essential that some such provision be made whereby the sewage can be disposed of in case of accident to pumps, pumping station or force-main, but this overflow should be used only in an emergency, and not in the ordinary operation of the works.

Provision for blow-offs from the force-main has also been made, at points where depressions occur, and the places for these blow-offs appear to be the best that it is practicable to select. They must be considered, of course, only as provisions for unforeseen emergencies, and not for frequent or regular use.

The proposed filtration area is located in a nearly uninhabited region, and contains a porous soil well adapted to the disposal of sewage by intermittent filtration. Plans for the preparation of the filtration area in detail have not yet been presented to the Board, but the preliminary examinations indicate that the area is ample for the disposal of all of the sewage of Taunton for many years in the future.

UNITED STATES ARSENAL AT WATERTOWN. The following communication was addressed to the commandant of the United States Arsenal at Watertown, with reference to the disposal of the sewage of the arsenal into the Charles River: —

Nov. 4, 1897.

For several years the work of preventing the pollution of the Charles River and improving its sanitary condition has been going forward under the direction of the State and of the local communities along the stream, and, by the construction of the metropolitan sewerage system, at a cost of more than $5,000,000, and of tributary sewerage systems in all the populous towns bordering the river in the lower portion of its course, a means of disposing of sewage without discharging it into the river has been provided, and practically all sewage is now diverted from the river. The sewers from the United States Arsenal buildings at Watertown, however, still discharge directly into the stream.

A system of sewerage has been constructed by the town of Watertown, and it is feasible, by the construction of a sewer through the Arsenal grounds, to intercept the sewage from the government buildings, and convey it to one of the town sewers which passes through the easterly end of the Arsenal grounds and connects with the metropolitan sewer on the southerly side of the river, and thus dispose of it in connection with the general system for the Charles River valley.

Under the circumstances, the United States government ought now to remove its sewage from the river, and dispose of it in connection with the general sewage-disposal system of the valley, which has been constructed at a large expense, with special reference to preventing the pollution of this stream. The Board, therefore, presents you this statement of the facts, in order that you may look into the matter and urge the proper authorities to provide means for diverting the sewage of the buildings and grounds of the United States Arsenal from the river, and thus remove the most serious source of pollution of the stream that now exists in this region.

WAREHAM (Onset Bay). The Onset Bay Grove Association applied to the Board, Nov. 20, 1896, for its advice relative to a proposed system of sewerage and sewage disposal for the summer resort known as Onset Bay. The Board replied to this application as follows: —

FEB. 5, 1897.

The State Board of Health received from you, on Nov. 20, 1896, an application for advice with reference to a proposed plan of sewerage and sewage disposal for a portion of the village of Onset in the town of Wareham, accompanied by a general description of the proposed plan and a sketch of the village, showing the proposed location of sewers and of a filter bed on the shore of East River at Wabun Grove.

It appears from your application that it is proposed that the sewage from the buildings shall be discharged into catch-basins or cess-pools, from which the liquid will be allowed to overflow into the sewers, while the solid matter would be removed from openings at the top of the catch-basins. It is suggested that the proposed sewers on the easterly side of the village would relieve the most congested part, and that, if they should work satisfactorily, another sewer could be constructed in West Central Avenue, with a filter bed on the westerly side of the village.

The Board has caused an examination of the village and of the location of the proposed filter bed near East River to be made by one of its engineers, and has examined the proposed plan. It appears that the proposed filter bed is situated between one of the public streets and the high-water line in the river, and consists of a strip of land approximately 100 feet in width by 2,000 feet in length, much of which is very little above the level of high water. It further appears that it is proposed to construct a flush tank beneath or in the vicinity of the street, from which sewage would be conveyed across the street and discharged at various points, and allowed to filter through a prepared bed of sand and stones into the East River. Judging from the elevation at which the proposed flush tank would be constructed, it does not appear practicable to discharge the sewage upon the surface of the filter bed, but it is understood that you propose to filter the sewage laterally through the bed.

The Board has carefully considered the proposed plan, and concludes that it would be impracticable to purify any considerable quantity of sewage upon the proposed filtration area by this method. Moreover, the scheme would provide for only a part of the thickly settled portion of the village; and, even if suitable filter beds for the easterly system could be constructed at the place proposed, the cost would be large, and the location is undesirably near the thickly settled portion of the village. It is very important, also, to avoid the construction of the proposed catch-basins, which are not only unnecessary in connection with a properly de-

signed system of sewerage, but which would be the sources of serious nuisances.

The Board would, therefore, advise that you have a further investigation made by an engineer of experience in designing systems of sewerage and sewage disposal, with a view to the collection of all the sewage of the village and its disposal at some suitable place, as remote as practicable from dwellings, and in such manner that the sewage may not pollute the bay or local water courses.

Webster. The sewer committee of Webster applied to the Board, Dec. 1, 1897, for its advice relative to the sewerage and sewage disposal of Webster, involving treatment upon land in the valley of French River. The Board replied to this application as follows: —

Jan. 7, 1898.

The State Board of Health received from you, on Dec. 1, 1897, an application for advice as to a proposed system of sewerage and sewage disposal for the town of Webster, in which you state that it is proposed to collect the sewage into a main sewer passing along the French River and discharging into receiving reservoirs at a place about a mile south of the town, from which it is proposed to pump it upon land in the vicinity and then purify it by intermittent filtration.

The application was accompanied by a plan, showing the area which it is proposed to use for sewage-disposal purposes, including the approximate location of the pumping station and receiving reservoirs.

The Board has examined the plans and has caused the land which you propose to use for sewage-disposal purposes to be examined by one of its engineers, and samples of the soil to be analyzed. The proposed filtration area is situated on the easterly side of the French River, about one mile south of the main village of Webster, and lies on both sides of the Norwich and Worcester division of the New England Railroad, south of the point where it is joined by the Southbridge branch. The area appears to be well situated for the purpose for which it is proposed to use it; and the examinations of samples of soil from test pits in various parts of the area, both east and west of the railroad, show that the soil found beneath the layer of loam at the surface is of excellent quality for the disposal of sewage by intermittent filtration. With properly prepared filter beds upon this area the sewage can be purified so thoroughly that the effluent may be discharged into the French River without danger of causing any trouble from the stream below.

It is understood that large quantities of wool are scoured at the mills located in the town, and that the sewage from this process will be taken into the sewers when they shall have been constructed. The Board has

no information as to the amount of this manufacturing sewage or its character; and, while it is essential that the manufacturing sewage be removed from the river as far as possible, experience with the sewage from other wool-scouring establishments indicates that it may not be necessary to take into the sewers all the liquid from the mills, but that it may be necessary to subject at least a portion of it to some process for removing solid matters which would tend to clog the sewers and filters.

Plans showing in detail the proposed storage tanks, pumping station and filter beds have not as yet been submitted. The plan in general is, in the opinion of the Board, an appropriate one for the disposal of the sewage of the town of Webster.

Pollution of Streams, Ponds and Sources of Water Supply.

The following is the substance of the action of the Board in reply to applications made during 1897 for advice in regard to the pollution of ponds and streams used as sources of water supply: —

New Bedford. A letter was received from the board of health of New Bedford, Nov. 3, 1897, stating that "a very severe case of typhoid fever had made its appearance among the Italian colony at work upon the water-shed of the New Bedford water supply." The attention of the State Board of Health was called to the fact that the water-shed was in the limits of a neighboring town, and hence the advice of the State Board was desired with reference to the same. The Board replied to this letter as follows: —

Nov. 6, 1897.

In response to your request of November 3, the Board has caused an examination to be made with reference to the case of typhoid fever at Little Quittacas Pond, and of the conditions prevailing along the conduit line through the water-shed of the Acushnet reservoir.

The case of typhoid fever referred to occurred among laborers employed in constructing the pumping station at Little Quittacas Pond, who reside in a camp near the south-westerly shore of the pond, and within its water-shed. The pipe line through which the water is to be pumped from this pond to the city has not yet been completed, so that the only means of drawing water from this pond is through a canal by means of which it is discharged into one of the feeders of the Acushnet reservoir. It appears, however, that this canal has been closed for some time, and that no water is at present being drawn from Little Quittacas Pond for the supply of the city of New Bedford, and that you do not propose to draw any water from this source for several months.

The new pipe line from Little Quittacas Pond to the city passes through the water-shed of Roaring Brook, one of the feeders of Acushnet reservoir, from which your present supply of water is drawn. There are two camps of laborers along this pipe line, the most south-westerly one being close to the brook, while the other is about three-quarters of a mile north-easterly from this camp, but still within the water-shed of Roaring Brook. It appears that one of the laborers living in the latter camp has been taken ill recently with a disease which is thought to be typhoid fever, and it is understood that this man worked along the pipe line between this camp and Roaring Brook, but it is not possible to determine whether the brook was polluted by this case.

Where large numbers of laborers are employed upon work such as that now being done within the water-shed of the New Bedford reservoir, it is difficult to insure the collection of human excrement and other waste material at any specially provided place or places; but, by providing receptacles for such matter and by a careful policing of the water-shed, much can be done in preventing the danger of polluting local water courses. The danger of pollution of water courses by laborers working upon a water-shed may also be lessened by having a careful medical inspection made of the men at frequent intervals, so that any sickness among them may be detected.

In your present circumstances, the Board would advise that all human excrement and other refuse matter that can be found, either on the water-shed of Acushnet reservoir or Little Quittacas Pond, be gathered and disposed of in some suitable manner, and that privies, or, what is better, earth-closets, be provided for the use of employees, and that the region be policed to prevent the pollution of other localities. It is also advised that you have a careful medical inspection of the employees made at frequent intervals, in order that any illness among them may be detected in the beginning. It is important that the camp located in the vicinity of Roaring Brook be removed, and that all camps be so located as to be remote from streams.

The danger from the case at Little Quittacas Pond seems more remote at present than the danger of the pollution of the Acushnet reservoir, from which your supply is now wholly drawn; and the first efforts should be directed to preventing any further danger of the pollution of the feeders of this reservoir.

Should you desire any further advice in the matter, the Board will, upon application, give the matter prompt attention.

Needham. The Board received a letter from the water commissioners of Needham, Nov. 11, 1897, stating their belief that the keeping of swine in large numbers on the water-shed of the public water supply of the town is a constant and increasing menace to the purity of the water, and at the same time requesting the Board to

make an examination of the territory and "make such recommendations and take such action as will enable the water commissioners to secure the abatement of the cause of pollution in the quickest manner possible." The Board replied to this application as follows: —

JAN. 6, 1898.

In accordance with your request, the Board has caused the locality to be examined by its engineer and a careful investigation to be made as to the sources of pollution within the water-shed of the brook near which the well used as a source of water supply of the town is located. As a result of this investigation, the Board finds that large numbers of swine and other animals are kept at several places within the water-shed of the brook. Many of these places are situated in close proximity to the brook or its tributaries, and the board concurs in your opinion that they are a menace to the purity of the water of the well from which the water supply of the town is taken.

An examination of the results of chemical analyses of samples of water collected from the well from time to time since the works were first constructed shows that while the water is at present of excellent quality, it has shown a slight tendency to deteriorate in recent years.

In view of all the circumstances, the Board is of the opinion that it is important to reduce the pollution on the water-shed as much as practicable, and the removal of the piggeries is an important step in this direction. The board of health of Needham appears to have power to cause the removal of any nuisances of this sort existing upon the water-shed.

WHITMAN. An application was received from the board of health of Whitman, Feb. 4, 1897, for the advice of the State Board of Health relative to the best mode of protecting the purity of the water supply of the town from pollution by the drainage of certain houses and stables in the town. The Board replied to this application as follows: —

MARCH 30, 1897.

The State Board of Health received from you, on Feb. 4, 1897, an application for advice with reference to protecting the purity of the water supply of Whitman, in which you state that the supply is polluted by sink waste and the contents of stable basements.

The source of water supply of the town of Whitman is a filter gallery on the easterly side of Hobart's Pond, supplemented with water drawn directly from the pond.

It appears, from information furnished by you, that there is a drain running from the vicinity of Temple Street in the village of Whitman to a small pond in the park, and thence to a brook flowing into Hobart's Pond, which

is designed to carry off the surface drainage from territory near the centre of the village, and that you believe that polluting matters are being discharged directly into this drain. If this is the case, it is within the power of your board to prevent the discharge of sewage into the drain, and the disposal of sewage in this way should be prevented. The method of procedure in such cases is prescribed by statute. There would, however, still be danger that the water entering the drain might be polluted, especially as there are no sewers to remove the sewage from the region which the drain is designed to serve, and, in order to avoid all danger of the pollution of Hobart's Pond by this drain, it would be best to divert it from its present outlet and discharge it into the stream below the outlet of the pond.

But if all danger of pollution of your water supply by this drain should be removed, other sources of pollution would still remain, some of which may be more serious than the one under consideration. From a general examination of the water-shed of Hobart's Pond and the stream which feeds it, it appears that there are about 4,500 people living within the water-shed of the pond in the villages of North Abington, Abington and Whitman, equivalent to a population of about 670 persons per square mile, and as none of these villages are provided with sewerage systems, though they have public water-supplies, much sewage necessarily finds its way directly or indirectly into the streams, and chemical analyses of samples of water collected at several points on the main stream above Hobart's Pond show marked evidences of sewage contamination.

Under the circumstances, the Board is of the opinion that the water of Hobart's Pond in its present state is unsafe for drinking, and would continue to be so after diverting the water of the drain in Whitman away from the pond. Moreover, analyses of water of the filter gallery made by the Board from time to time for several years indicate that the water is derived largely by filtration through the ground from Hobart's Pond; and the high color and large amount of organic matter and of iron found in the water at times indicate that a portion, and perhaps the greater portion, of the water entering the filter gallery comes so directly from the pond that it is not thoroughly purified in its passage through the ground, and the water of the filter gallery cannot be regarded as safe for drinking.

It is probable that the danger of the pollution of the pond could be considerably lessened by a careful and constant inspection of the water-shed, to prevent sewage entering any of the streams; but the cost would be large, and it would be very difficult, even if sewers are constructed in the villages, to prevent all danger of the pollution of Hobart's Pond from the population within its water-shed. It appears that measures have already been taken by the town to secure a water supply from another source, and the Board would advise that a new supply be introduced from some suitable source as soon as possible, and the use of your present polluted sources for domestic purposes be discontinued.

Examination of Water Supplies.

EXAMINATION OF WATER SUPPLIES.

EXPLANATORY NOTE.

The systematic examination of the water supplies of the State was begun June 1, 1887, and has been continued up to the present time. The results of the investigations made during the first two years were published in a special report of the Board upon the Examination of Water Supplies (1890), and of those made during succeeding years in the annual reports of the Board beginning with the Twenty-second Annual Report (1890).

The special report contains a description of each of the water supplies in the State existing at the date of that report, and the annual reports contain descriptions of new works and changes in existing works.

In all of these reports an alphabetical arrangement by towns has been adopted. Sources of water supply are tabulated under the name of the town supplied, other waters under the name of the town in which they are situated. The analyses of water from the larger rivers not used as sources of water supply are given in a subsequent tabulation, headed "Examination of Rivers."

The method of making the chemical examinations remains unchanged, and the results are presented in the tables of this report in the same form as in the last one.

The samples of water are usually received at the laboratory from twenty-four to forty-eight hours after collection. All surface water and such samples of ground water as contain suspended matter are filtered through filter-paper before determining the color, the residue on evaporation and the albuminoid ammonia in solution. Some ground waters which are perfectly clear and colorless when drawn from the ground become turbid and colored on standing, in consequence of the oxidation of the iron which they contain. In these waters the residue on evaporation is determined without filtration, since this iron is an essential and not an accidental ingredient in the water. In the changes which accompany the oxidation of the iron in waters of this character, they become first cloudy (well described by the word *milky*) and finally deposit a precipitate of oxide of iron. In the cloudy condition they have a distinct color, which, while it does not have the same significance as in the case of surface waters, and is only a passing phenomenon, is, nevertheless, of interest as showing a color which the water may assume while the oxidation of the iron is in progress. When the iron is all oxidized and precipitated the water may become colorless again. In some cases, however, the iron occurs in combination with organic matter, forming a much more stable body. In such cases the water is of a brown color when first drawn from the ground, and, while the iron begins to oxidize soon after the water is exposed to the air, the process goes on slowly and the water may remain colored and iron continue to precipitate for a long time.

The color of water is expressed by numbers which increase with the amount of color. The standard used is nesslerized ammonia, as described on page 531 of the Special Report upon the Examination of Water Supplies, 1890, and on page 329 of

the Annual Report for 1892. Boston water, as drawn from a tap at the State House, had an average color in 1897 of 0.65. Other water supplies in the State had an average color of from 0 to 1 83.

In cases where examinations of a source have been made with regularity for several years, and the character of the water has changed materially during the time that the examinations have been made, the averages of the chemical analyses of each year are given. In other cases, the average of the analyses made during the year 1897 only is given.

The method of making the microscopical examinations of water has been changed several times since the examinations were begun in 1887. The method employed at the present time is fully described in the Twenty-third Annual Report of the Board for the year 1891 (pages 395–421), and in the explanatory note on page 82 of the Annual Report for the year 1896. The earlier methods employed were less perfect, so that a smaller proportion of the total number of organisms present in the water was separated from it and observed under the microscope; and, before drawing conclusions from a comparison of the microscopical examinations of water made at different times, the explanatory notes on page 70 of the Annual Report for 1890 and on page 82 of the Annual Report for 1896 should be read.

To indicate the amount of the so-called *Zoöglœa* observed, the number of individual masses is not counted, but an area equal to 2,500 square microns, or .0025 square millimeters, has been adopted as an arbitrary unit.

In the classification of the microscopical organisms into groups, the same system has been adopted as in previous years. The plants observed are classified in four groups, viz. : Diatomaceæ, Cyanophyceæ, Algæ and Fungi. The animals observed are grouped as Rhizopoda, Infusoria, Vermes and Crustacea.

In cases where the organisms found in the water are present only in small numbers, and consist of those genera which have not hitherto been known to cause serious trouble in water supplies, the results of the microscopical examinations have not been printed in this report. In other cases the following rules have been generally adopted in printing the results : —

1. All genera of the Cyanophyceæ and Infusoria are included in which the number observed in any one sample was as much as 10 per cubic centimeter.

2. All genera of the other groups are included in which the number observed in any one sample was as much as 50 per cubic centimeter.

In both of the above cases the total number of organisms in each group is given even when the different genera are not specified.

In the case of a few of the organisms, such as *Uroglena* and *Synura*, which have been known to give trouble, even when occurring in very small numbers, the results are given, even if the number observed was less than 10.

Fractions are omitted from the table, the nearest whole number of organisms per cubic centimeter being given. Where the number observed is 0.5 or less, the fact that the organism was present is indicated by the abbreviation "pr."

EXAMINATION OF WATER SUPPLIES.

WATER SUPPLY OF ABINGTON AND ROCKLAND.

Chemical Examination of Water from Big Sandy Pond, Pembroke.

[Parts per 100,000.]

Number.	Date of Collection.	Appearance.			Residue on Evaporation.		Ammonia.				Chlorine.	Nitrogen as		Oxygen Consumed.	Hardness.
		Turbidity.	Sediment.	Color.	Total.	Loss on Ignition.	Free.	Albuminoid. Total.	Albuminoid. Dissolved.	Albuminoid. Suspended.		Nitrates.	Nitrites.		
	1897.														
18448	Feb. 8	V. slight.	V. slight.	.08	3.05	1.10	.0004	.0174	.0158	.0016	.69	.0080	.0003	.16	0.6
19172	May 5	V. slight.	V. slight.	.15	2.90	0.75	.0014	.0174	.0160	.0014	.61	.0000	.0000	.22	0.5
20001	Aug. 4	V. slight.	V. slight.	.10	3.00	0.85	.0006	.0202	.0152	.0050	.66	.0020	.0000	.24	0.8
21040	Nov. 3	None.	V. slight.	.13	3.20	1.35	.0014	.0220	.0188	.0032	.69	.0000	.0000	.20	0.6
Av...	....	....	....	.11	3.04	1.01	.0009	.0192	.0164	.0028	.66	.0025	.0001	.20	0.6

Odor of the first three samples, distinctly vegetable; of the last, faintly earthy, becoming stronger on heating.——The samples were collected from a faucet at the pumping station.

WATER SUPPLY OF ADAMS FIRE DISTRICT, ADAMS.

Chemical Examination of Water from Bassett Brook Reservoir, Adams.

[Parts per 100,000.]

Number.	Date of Collection.	Appearance.			Residue on Evaporation.		Ammonia.				Chlorine.	Nitrogen as		Oxygen Consumed.	Hardness.
		Turbidity.	Sediment.	Color.	Total.	Loss on Ignition.	Free.	Albuminoid. Total.	Albuminoid. Dissolved.	Albuminoid. Suspended.		Nitrates.	Nitrites.		
	1897.														
18614	Feb. 22	None.	V. slight.	.02	3.60	1.05	.0004	.0030	.0020	.0010	.08	.0170	.0000	.07	2.2
19113	Apr. 26	V. slight.	V. slight.	.07	1.85	0.50	.0004	.0040	.0040	.0000	.06	.0220	.0000	.15	0.9
19578	June 25	None.	V. slight.	.02	4.00	0.95	.0002	.0052	.0052	.0000	.05	.0100	.0000	.16	2.6
20278	Aug. 25	None.	V. slight.	.05	4.80	0.95	.0006	.0028	.0024	.0004	.08	.0100	.0000	.13	3.4
21066	Nov. 8	V. slight.	Slight.	.10	3.65	1.25	.0004	.0064	.0064	.0000	.11	.0120	.0000	.15	2.1
Av...	....	....	....	.05	3.58	0.94	.0004	.0043	.0040	.0003	.08	.0142	.0000	.13	2.2

Odor of the second and fourth samples, faintly vegetable; of the others, none.——Nos. 19113 and 19578 were collected from the reservoir; the others, from a faucet supplied with water from the reservoir.

ADAMS.

Chemical Examination of Water from Dry Brook Reservoir in Adams and Cheshire.

[Parts per 100,000.]

Number.	Date of Collection.	Appearance.			Residue on Evaporation.		Ammonia.				Chlorine.	Nitrogen as		Oxygen Consumed.	Hardness.
		Turbidity.	Sediment.	Color.	Total.	Loss on ignition.	Free.	Albuminoid. Total.	Albuminoid. Dissolved	Albuminoid. Sus-pended.		Nitrates.	Nitrites.		
	1897.														
18615	Feb. 22	V. slight.	Slight.	.20	5.80	1.70	.0008	.0064	.0060	.0004	.12	.0180	.0000	.28	3.3
19112	Apr. 26	V. slight.	Slight.	.45	4.30	1.55	.0014	.0158	.0142	.0016	.08	.0070	.0000	.53	2.6
19577	June 25	None.	Slight.	.23	7.65	1.70	.0012	.0118	.0118	.0000	.09	.0070	.0000	.30	5.3
20277	Aug. 25	None.	V. slight.	.16	8.05	1.80	.0006	.0084	.0074	.0010	.13	.0080	.0000	.33	6.1
21065	Nov. 8	None.	V. slight.	.36	8.05	2.70	.0010	.0112	.0102	.0010	.17	.0060	.0001	.43	6.5
Av...	....	....	....	.28	6.77	1.89	.0010	.0107	.0099	.0008	.12	.0092	.0000	.37	4.9

Odor of the first and last samples, none; of the second, none, becoming faintly vegetable on heating; of the third and fourth, distinctly vegetable.—— No. 19577 was collected from the reservoir; the others, from a faucet supplied with water from the reservoir.

Water Supply of Amesbury — Powow Hill Water Company.

Chemical Examination of Water from Tubular Wells supplying Open Basins near Main Street.

[Parts per 100,000.]

Number.	Date of Collection.	Appearance.			Residue on Evaporation.	Ammonia.		Chlorine.	Nitrogen as		Oxygen Consumed.	Hardness.	Iron.
		Turbidity.	Sediment.	Color.		Free.	Albu-minoid.		Nitrates.	Nitrites.			
	1897.												
19810	July 16	Slight.	V. slight.	.02	9.90	.0016	.0028	.51	.0380	.0001	.05	4.9	.0120
21273	Nov. 16	Slight.	None.	.08	10.40	.0012	.0028	.50	.0420	.0003	.01	5.6	.0070
21272	Nov. 16	None.	None.	.07	11.40	.0006	.0022	.44	.0050	.0001	.01	7.1	.0060

Odor, none.—— The first two samples were collected at the pumping station on Main Street; the third, from one of the tubular wells situated about 15 feet from the open basin and driven to a depth of 135 feet, the last 35 feet being through rock.

AMESBURY.

Chemical Examination of Water from Thirty-six Tubular Wells near Market Street.

[Parts per 100,000.]

Number.	Date of Collection.	Appearance.			Residue on Evaporation.	Ammonia.		Chlorine.	Nitrogen as		Oxygen Consumed.	Hardness.	Iron.
		Turbidity.	Sediment.	Color.		Free.	Albuminoid.		Nitrates.	Nitrites.			
	1897.												
19804	July 15	None.	V. slight.	.00	21.70	.0038	.0034	1.29	.0070	.0007	.07	14.5	.0050

Odor, none. —— The sample was collected at the pumping station on Market Street.

Water Supply of Andover.

Chemical Examination of Water from Haggett's Pond, Andover.

[Parts per 100,000.]

Number.	Date of Collection.	Appearance.			Residue on Evaporation.		Ammonia.				Chlorine.	Nitrogen as		Oxygen Consumed.	Hardness.
								Albuminoid.							
		Turbidity.	Sediment.	Color.	Total.	Loss on Ignition.	Free.	Total.	Dissolved.	Suspended.		Nitrates.	Nitrites.		
	1897.														
18471	Feb. 9	V. slight.	V. slight.	.12	3.35	1.50	.0008	.0176	.0160	.0016	.36	.0050	.0000	.25	1.4
19188	May 7	V. slight.	V. slight.	.22	3.30	1.30	.0012	.0166	.0154	.0012	.32	.0050	.0000	.34	1.4
19999	Aug. 4	V. slight.	None.	.14	3.40	1.30	.0008	.0168	.0132	.0036	.34	.0000	.0000	.33	1.0
21043	Nov. 4	None.	V. slight.	.12	3.15	1.25	.0008	.0184	.0170	.0014	.38	.0000	.0000	.36	1.4
Av...	....	....	....	.15	3.30	1.34	.0009	.0173	.0154	.0019	.35	.0025	.0000	.32	1.3

Odor of the first three samples, vegetable; of the last, none, becoming faintly earthy on heating —— The samples were collected from a faucet at the pumping station.

ARLINGTON.

Water Supply of Arlington.

Chemical Examination of Water from the Storage Reservoir of the Arlington Water Works.

[Parts per 100,000.]

Number.	Date of Collection.	Appearance.			Residue on Evaporation.		Ammonia.				Chlorine.	Nitrogen as		Oxygen Consumed.	Hardness.
		Turbidity.	Sediment.	Color.	Total.	Loss on Ignition.	Free.	Albuminoid. Total.	Albuminoid. Dissolved.	Albuminoid. Suspended.		Nitrates.	Nitrites.		
	1897.														
18408	Feb. 1	Distinct, green.	Slight, green.	.72	8.00	3.00	.0072	.0744	.0394	.0350	.64	.0320	.0003	0.87	2.7
18946	Apr. 2	Slight.	V. slight.	.75	6.65	3.25	.0046	.0368	.0238	.0130	.52	.0500	.0001	0.76	2.1
19404	June 7	Slight.	V. slight.	.90	6.25	2.55	.0010	.0500	.0276	.0224	.48	.0030	.0000	0.88	2.1
19993	Aug. 4	Distinct.	Slight.	.85	8.05	3.95	.0016	.0896	.0462	.0434	.58	.0020	.0000	1.02	2.2
20746	Oct. 11	Distinct.	Slight.	.60	8.65	4.10	.0000	.0682	.0356	.0326	.66	.0020	.0000	0.81	2.6
21509	Dec. 13	Decided.	Slight.	.95	7.90	3.65	.0016	.0540	.0372	.0168	.66	.0380	.0006	0.82	2.9
Av.	....	....	....	.79	7.58	3.42	.0027	.0622	.0350	.0272	.59	.0212	.0001	0.86	2.4

Odor, generally distinctly vegetable and occasionally grassy or unpleasant. —— The samples were collected from the reservoir, near the gate house.

Microscopical Examination of Water from the Storage Reservoir of the Arlington Water Works.

[Number of organisms per cubic centimeter.]

	1897. Feb.	April.	June.	Aug.	Oct.	Dec.
Day of examination,	3	3	11	5	12	14
Number of sample,	18408	18946	19404	19993	20746	21509
PLANTS.						
Diatomaceæ,	**4**	**415**	**1,926**	**44**	**412**	**578**
Asterionella,	0	380	128	0	0	412
Fragilaria,	0	9	0	24	156	70
Melosira,	0	0	46	0	176	24
Synedra,	4	24	1,752	12	80	64
Cyanophyceæ,	**0**	**0**	**152**	**1,052**	**568**	**42**
Anabæna,	0	0	44	12	296	6
Clathrocystis,	0	0	108	1,040	272	36
Algæ,	**816**	**1**	**296**	**118**	**190**	**198**
Chlorococcus,	756	0	2	0	0	0
Cosmarium,	0	0	4	6	76	0
Protococcus,	60	0	12	50	16	0
Scenedesmus,	0	1	232	12	60	156

ARLINGTON.

Microscopical Examination of Water from the Storage Reservoir of the Arlington Water Works — Concluded.

[Number of organisms per cubic centimeter.]

	1897.					
	Feb.	April.	June.	Aug.	Oct.	Dec.
ANIMALS.						
Infusoria,	524	1	7	0	6	54
Cryptomonas,	32	0	0	0	0	0
Dinobryon,	476	0	0	0	0	0
Peridinium,	0	1	0	0	0	52
Vermes,	12	0	0	0	2	2
Miscellaneous, Zoöglœa,	100	40	40	60	20	60
TOTAL,	1,456	457	2,421	1,274	1,198	934

Chemical Examination of Water from Tubular Wells at East Lexington.

[Parts per 100,000.]

Number.	Date of Collection.	Appearance. Turbidity.	Appearance. Sediment.	Appearance. Color.	Residue on Evaporation.	Ammonia. Free.	Ammonia. Albuminoid.	Chlorine.	Nitrogen as Nitrates	Nitrogen as Nitrites.	Oxygen Consumed.	Hardness.	Iron.
	1897.												
18409	Feb. 1	Distinct, milky.	Slight.	.33	9.70	.0140	.0098	.56	.0070	.0001	.22	4.3	.0500
18978	Apr. 7	Slight.	Slight.	.35	8.60	.0146	.0104	.55	.0050	.0001	.19	4.9	.0430
19393	June 7	Distinct, milky.	Cons., floc.	.50	7.50	.0150	.0080	.44	.0030	.0000	.25	3.8	.1450
20074	Aug. 11	Distinct.	Slight.	.66	9.30	.0214	.0102	.73	.0050	.0000	.25	4.9	.1800
20749	Oct. 11	Slight, milky.	V. slight.	.45	10.00	.0164	.0094	.52	.0030	.0000	.22	5.0	.0680
21508	Dec. 13	Decided.	Cons.	.43	9.20	.0188	.0134	.52	.0020	.0001	.18	5.4	.1100

Averages by Years.

-	1895	-	-	.17	9.90	.0097	.0075	.52	.0045	.0001	.18	5.5	.0958
-	1896	-	-	.24	9.88	.0090	.0102	.54	.0052	.0001	.21	5.3	.0742
-	1897	-	-	.45	9.05	.0167	.0102	.55	.0042	.0000	.22	4.7	.0993

NOTE to analyses of 1897: Odor in April, faintly unpleasant, becoming distinctly mouldy on heating; in August, faintly earthy, becoming faintly musty on heating; in December, none, becoming faintly vegetable on heating; at other times, none. —— The samples were collected from a faucet at the pumping station.

Microscopical Examination.

The average number of organisms per cubic centimeter found in these samples was 603, consisting chiefly of *Crenothrix*.

ASHBURNHAM.

Ashburnham.

Chemical Examination of Water from Upper Naukeag Pond, Ashburnham.

[Parts per 100,000.]

Number.	Date of Collection.	Appearance. Turbidity.	Appearance. Sediment.	Appearance. Color.	Residue on Evaporation. Total.	Residue on Evaporation. Loss on Ignition.	Ammonia. Free.	Ammonia. Albuminoid. Total.	Ammonia. Albuminoid. Dissolved.	Ammonia. Albuminoid. Suspended.	Chlorine.	Nitrogen as Nitrates.	Nitrogen as Nitrites.	Oxygen Consumed.	Hardness.
	1897.														
18692	Mar. 2	None.	V. slight.	.07	2.10	.85	.0010	.0096	.0088	.0008	.18	.0030	.0000	.29	0.5
19311	May 25	V. slight.	V. slight.	.15	1.40	.50	.0004	.0134	.0120	.0014	.12	.0030	.0000	.23	0.2
20320	Aug. 30	None.	None.	.08	1.70	.90	.0010	.0128	.0114	.0014	.10	.0020	.0000	.28	0.0
21318	Nov. 22	None.	Slight.	.14	1.85	.85	.0030	.0168	.0150	.0018	.14	.0030	.0000	.22	0.3
Av...	....	....	....	.11	1.76	.77	.0013	.0131	.0118	.0013	.13	.0027	.0000	.25	0.2

Odor of the second sample, none; of the others, vegetable. —— The samples were collected from the pond, about 4 feet beneath the surface.

Microscopical Examination.

An insignificant number of organisms was found in each of these samples.

Water Supply of Athol. — Athol Water Company.

Chemical Examination of Water from the Large Reservoir in Phillipston.

[Parts per 100,000.]

Number.	Date of Collection.	Appearance. Turbidity.	Appearance. Sediment.	Appearance. Color.	Residue on Evaporation. Total.	Residue on Evaporation. Loss on Ignition.	Ammonia. Free.	Ammonia. Albuminoid. Total.	Ammonia. Albuminoid. Dissolved.	Ammonia. Albuminoid. Suspended.	Chlorine.	Nitrogen as Nitrates.	Nitrogen as Nitrites.	Oxygen Consumed.	Hardness.
	1897.														
18294	Jan 19	V. slight.	V. slight.	0.80	4.90	2.25	.0028	.0272	.0246	.0026	.16	.0050	.0000	0.80	0.8
18798	Mar. 16	V. slight.	V. slight.	0.70	3.75	1.45	.0020	.0256	.0228	.0028	.20	.0070	.0000	0.70	0.6
19260	May 17	V. slight.	Slight.	0.65	2.85	1.35	.0026	.0264	.0190	.0074	.11	.0000	.0000	0.66	0.5
19826	July 19	Distinct.	Slight.	1.32	4.30	2.75	.0014	.0856	.0414	.0442	.14	.0000	.0000	1.39	0.6
20566	Sept. 20	Slight.	Slight.	0.70	4.05	2.55	.0004	.0692	.0352	.0340	.10	.0000	.0000	0.90	0.6
21355	Nov. 24	Slight.	Cons.	0.99	4.30	2.25	.0012	.0274	.0232	.0042	.19	.0060	.0000	1.00	1.4

Averages by Years.

–	1894	–	–	0.45	3.75	1.39	.0019	.0179	.0112	.0067	.11	.0048	.0000	0.47	0.9
–	1895	–	–	0.64	4.00	1.64	.0016	.0364	.0174	.0190	.16	.0110	.0000	0.61	1.0
–	1896	–	–	0.74	3.66	1.57	.0014	.0447	.0251	.0196	.14	.0078	.0000	0.99	0.7
–	1897	–	–	0.86	4.02	2.10	.0017	.0436	.0277	.0159	.15	.0030	.0000	0.91	0.7

NOTE to analyses of 1897: Odor, generally distinctly vegetable. —— The samples were collected from the reservoir.

ATHOL.

Microscopical Examination of Water from the Large Reservoir in Phillipston.

[Number of organisms per cubic centimeter.]

	1897.					
	Jan.	March.	May.	July.	Sept.	Nov.
Day of examination,	21	18	18	21	21	29
Number of sample,	18294	18798	19260	19826	20566	21355
PLANTS.						
Diatomaceæ,	323	4	4,143	8	2,004	705
Asterionella,	316	4	2,800	2	1,440	580
Melosira,	0	0	1,340	6	548	16
Synedra,	6	0	0	0	4	104
Cyanophyceæ,	0	0	0	0	12,006	1,300
Anabæna,	0	0	0	0	12,000	1,300
Algæ,	44	2	3	7	168	18
Protococcus,	0	0	0	1	156	13
ANIMALS.						
Rhizopoda, Arcella,	0	0	0	0	2	0
Infusoria,	33	299	2	3	10	2
Dinobryon,	32	11	1	0	0	0
Raphidomonas,	0	288	0	0	0	0
Vermes,	1	1	0	5	4	0
Crustacea, Bosmina,	0	0	0	0	0	pr.
Miscellaneous, Zoöglœa,	25	0	50	60	10	20
TOTAL,	426	306	4,198	83	14,204	2,045

WATER SUPPLY OF ATTLEBOROUGH.

Chemical Examination of Water from the Well of the Attleborough Water Works.

[Parts per 100,000.]

Number.	Date of Collection.	Appearance.			Residue on Evaporation.	Ammonia.		Chlorine.	Nitrogen as		Oxygen Consumed.	Hardness.	Iron.
		Turbidity.	Sediment.	Color.		Free.	Albuminoid.		Nitrates.	Nitrites.			
	1897.												
18324	Jan. 20	None.	None.	.00	4.50	.0008	.0024	.40	.0150	.0000	.00	1.7	.0080
18469	Feb. 9	None.	None.	.00	3.20	.0000	.0018	.40	.0180	.0000	.00	1.4	.0020
18738	Mar. 9	None.	None.	.00	3.10	.0000	.0028	.43	.0100	.0000	.02	1.7	.0000
19049	Apr. 14	None.	None.	.00	3.20	.0010	.0010	.40	.0150	.0000	.06	1.6	.0030
19252	May 14	None.	None.	.02	4.40	.0006	.0034	.40	.0150	.0000	.03	1.6	.0000
19499	June 17	None.	None.	.00	4.50	.0006	.0024	.31	.0150	.0000	.05	1.8	.0000
19805	July 15	None.	None.	.00	4.30	.0000	.0024	.35	.0130	.0000	.07	2.1	.0030
20096	Aug. 12	None.	None.	.00	4.70	.0006	.0030	.40	.0100	.0000	.07	1.8	.0040
20486	Sept. 14	None.	None.	.00	4.40	.0000	.0010	.38	.0080	.0000	.05	1.8	.0010
20767	Oct. 12	None.	None.	.00	3.70	.0006	.0008	.43	.0120	.0000	.02	2.0	.0060
21230	Nov. 11	V slight.	None.	.03	4.10	.0012	.0024	.54	.0600	.0003	.02	2.1	.0020
21622	Dec. 21	V. slight.	V. slight.	.04	4.80	.0010	.0020	.48	.0140	.0000	.02	2.2	.0000
Av...	....	....	....	.01	4.07	.0005	.0021	.41	.0171	.0000	.03	1.8	.0024

Odor, none.—The samples were collected from a faucet at the pumping station, while pumping.

AVON.

WATER SUPPLY OF AVON.

Chemical Examination of Water from the Well of the Avon Water Works.

[Parts per 100,000.]

Number.	Date of Collection.	Appearance.			Residue on Evaporation.	Ammonia.		Chlorine.	Nitrogen as		Oxygen Consumed.	Hardness.	Iron.
		Turbidity.	Sediment.	Color.		Free.	Albuminoid.		Nitrates.	Nitrites.			
	1897.												
19920	July 27	None.	None.	.00	4.00	.0000	.0004	.50	.0300	.0000	.05	1.1	.0010

Odor, none. —— The sample was collected from a faucet at the pumping station, while pumping.

WATER SUPPLY OF AYER.

Chemical Examination of Water from the Well of the Ayer Water Works.

[Parts per 100,000.]

Number.	Date of Collection.	Appearance.			Residue on Evaporation.	Ammonia.		Chlorine.	Nitrogen as		Oxygen Consumed.	Hardness.	Iron.
		Turbidity.	Sediment.	Color.		Free.	Albuminoid.		Nitrates.	Nitrites.			
	1897.												
19917	July 27	None.	Slight.	.00	6.10	.0000	.0022	.59	.0520	.0000	.06	2.7	.0000

Odor, none. —— The sample was collected from the well.

Chemical Examination of Water from the Distributing Reservoir of the Ayer Water Works.

[Parts per 100,000.]

Number.	Date of Collection.	Appearance.			Residue on Evaporation.		Ammonia.				Chlorine.	Nitrogen as		Oxygen Consumed.	Hardness.
								Albuminoid.							
		Turbidity.	Sediment.	Color.	Total.	Loss on Ignition.	Free.	Total.	Dissolved.	Suspended.		Nitrates.	Nitrites.		
	1897.														
18325	Jan. 21	Slight.	Slight.	.05	7.20	1.85	.0152	.0200	.0150	.0050	.68	.0400	.0002	.15	2.6
18326	Jan. 21	V. slight.	V. slight.	.03	7.00	1.95	.0006	.0070	.0066	.0004	.62	.0480	.0000	.07	2.9

Odor of the first sample, distinctly vegetable, becoming distinctly fishy and oily on heating; of the second, distinctly fishy and oily. —— The first sample was collected from the reservoir; the last, from a faucet in the town. The fishy and oily odor observed in the water was due to the presence of the organism *Uroglena* in the distributing reservoir, which is not covered.

BARRE.

Water Supply of Barre. — Barre Water Company.

Chemical Examination of Water from the Reservoir of the Barre Water Company.

[Parts per 100,000.]

Number.	Date of Collection.	Appearance.			Residue on Evaporation.		Ammonia.				Chlorine.	Nitrogen as		Oxygen Consumed.	Hardness.
								Albuminoid.							
		Turbidity.	Sediment.	Color.	Total.	Loss on Ignition.	Free.	Total.	Dissolved.	Suspended.		Nitrates.	Nitrites.		
	1897.														
18459	Feb. 8	V. slight.	V. slight.	.20	3.95	0.90	.0012	.0124	.0122	.0002	.17	.0130	.0000	.20	1.3
19193	May 9	Slight, milky.	V slight.	.18	2.80	0.65	.0030	.0162	.0140	.0022	.17	.0130	.0001	.19	0.9
20041	Aug. 10	Distinct.	V. slight.	.32	3.50	1.50	.0020	.0208	.0188	.0020	.08	.0030	.0000	.42	0.8
21091	Nov. 9	V. slight.	V. slight.	.12	3.25	1.20	.0034	.0166	.0166	.0000	.13	.0020	.0000	.24	1.8
Av...	1897	....	....	.20	3.37	1.06	.0024	.0165	.0154	.0011	.14	.0077	.0000	.26	1.2
Av...	1896	....	....	.13	4.67	1.18	.0019	.0151	.0121	.0030	.19	.0057	.0001	.25	1.7

Odor of the first three samples, faintly vegetable; of the last, none. —— Nos. 19193 and 20041 were collected from the reservoir; No. 18459, from a faucet on the main pipe line; No. 21091, from a faucet at the dead end of a pipe line.

Microscopical Examination.

No organisms were found in the first and last samples; in the second and third samples there were found 22 and 236 organisms per cubic centimeter respectively, consisting chiefly of *Dinobryon*.

Water Supply of Belmont.

(See *Watertown.*)

Water Supply of Beverly.

(See *Salem.*)

Billerica.

The advice of the State Board of Health to the water supply committee of the town of Billerica, relative to a proposed water supply for that town, to be taken from the ground near the westerly bank of the Concord River, may be found on pages 4 and 5 of this volume.

In accordance with the advice of the Board, tests were made of the ground in the vicinity of the Concord River, a short distance below the Corner Bridge, so called, in November and December, 1897, by means of numerous test wells. On November 15 a pumping test, to obtain information as to the quantity and quality of water that might be obtained from the ground in this region, was begun by pumping with a steam pump from seven wells, numbered 11, 12, 13, 26, 42, 48 and 49. Several samples of water were collected in the course of this test, the results of which may be found in Table 1, which follows. This test was continued from November 15 to 24, and the water when first drawn from the ground had a strong odor like sulphuretted hydrogen, throughout the test. The odor disappeared after the water had been standing for a time.

In order to obtain information as to the quality of the water of the different wells, a portion of them were shut off at times, and samples collected from the remaining wells. The results of this examination are given in Table 2, which follows.

Owing to the unsatisfactory quality of the water, analyses were made of samples of water from a large number of the individual test wells in this locality, to determine the quality of the water in the various wells. The results of these examinations are given in Table 3, which follows.

As a result of these investigations, a second test was made, beginning on December 3, by pumping continuously from wells numbered 12*a*, 22, 24, 25, 32, 34 and 53. The test was discontinued on Dec. 11, 1897. The advice of the Board to the town of Billerica with reference to the use of water from the ground in this region may be found in a subsequent report.

BILLERICA.

Chemical Examination of Water from Tubular Test Wells on the Westerly Side of the Concord River.

TABLE 1.

[Parts per 100,000.]

Number.	Date of Collection.	Appearance.			Residue on Evaporation.	Ammonia.		Chlorine.	Nitrogen as		Oxygen Consumed.	Hardness.	Iron.
		Turbidity.	Sediment.	Color.		Free.	Albuminoid.		Nitrates.	Nitrites.			
	1897.												
21237	Nov. 15	V. slight.	None.	.41	6.00	.0018	.0052	.28	.0050	.0000	.18	2.2	.0580
21263	Nov. 16	None.	None.	.38	6.80	.0020	.0054	.27	.0030	.0001	.18	2.2	.0550
21290	Nov. 17	None.	None.	.32	6.10	.0008	.0038	.22	.0030	.0000	.22	3.3	.0540
21296	Nov. 17	None.	None.	.40	6.00	.0006	.0036	.20	.0030	.0000	.19	3.3	.0500
21303	Nov. 18	V. slight.	V. slight.	.30	6.10	.0018	.0044	.22	.0030	.0000	.20	2.6	.0460
21304	Nov. 19	None.	None.	.22	6.50	.0022	.0042	.22	.0030	.0000	.20	2.7	.0500
21309	Nov. 20	Slight.	Slight.	.31	6.30	.0044	.0046	.24	.0030	.0000	.18	2.7	.0650
21310	Nov. 21	V. slight.	V. slight.	.38	6.20	.0030	.0044	.24	.0030	.0000	.18	3.3	.0700
21325	Nov. 22	V slight.	None.	.30	6.30	.0038	.0060	.24	.0030	.0000	.16	3.3	.0210
21353	Nov. 23	V. slight.	None.	.38	7.00	.0028	.0058	.24	.0030	.0000	.18	3.1	.0440
21354	Nov. 24	V. slight.	None.	.35	6.90	.0028	.0068	.24	.0030	.0000	.18	3.3	.0430

All of the samples had a strong odor of sulphuretted or carburetted hydrogen when collected, but this odor had generally become quite faint or had entirely disappeared by the time the samples reached the laboratory. —— The samples were collected from the pipe discharging water from a steam pump while pumping from seven tubular wells, numbered 11, 12, 13, 26, 42, 48 and 49. The wells were located north of the Corner Bridge, the nearest well to the river being distant from it about 170 feet and the one farthest from the river about 500 feet. The test was begun on November 15, and pumping was continued until November 24.

Chemical Examination of Water from Tubular Test Wells on the Westerly Side of the Concord River.

TABLE 2.

[Parts per 100,000.]

Number.	Date of Collection.	Appearance.			Residue on Evaporation.	Ammonia.		Chlorine.	Nitrogen as		Oxygen Consumed.	Hardness.	Iron.
		Turbidity.	Sediment.	Color.		Free.	Albuminoid.		Nitrates.	Nitrites.			
	1897.												
21238	Nov. 15	V. slight.	Slight.	.07	5.10	.0006	.0052	.27	.0075	.0000	.11	1.8	.0020
21305	Nov. 19	V. slight.	V slight.	.32	6.20	.0010	.0056	.24	.0050	.0000	.18	3.0	.0040
21306	Nov. 19	Slight.	Slight.	.35	6.60	.0028	.0032	.24	.0030	.0000	.12	3.1	.0250
21307	Nov. 19	Decided.	Slight.	.19	6.30	.0010	.0036	.24	.0030	.0000	.10	3.0	.0180
21308	Nov. 19	None.	None.	.05	5.70	.0004	.0014	.22	.0070	.0000	.05	2.9	.0020

Odor, none. —— These samples also were collected from the pipe discharging water from a steam pump during the pumping test from Nov. 15 to 24, 1897, but at a time when a portion of the wells were shut off. Nos. 21238 and 21308 were collected while pumping from wells Nos. 12 and 49; No. 21305 was collected while pumping from wells Nos. 11 and 12; No. 21306 was collected while pumping from wells Nos. 12, 13 and 42; No. 21307 was collected while pumping from wells Nos. 12, 49, 48 and 26.

BILLERICA.

Chemical Examination of Water from Various Tubular Test Wells on the Westerly Side of the Concord River.

TABLE 3.

[Parts per 100,000.]

Number of Well.	Number.	Date of Collection.	Appearance.			Residue on Evaporation.	Ammonia.		Chlorine.	Nitrogen as		Oxygen Consumed.	Hardness.	Iron.
			Turbidity.	Sediment.	Color.		Free.	Albuminoid.		Nitrates.	Nitrites.			
		1897.												
24	21120	Nov. 10	Slight.	V. slight.	.06	5.70	.0004	.0012	.21	.0060	.0000	.02	2.6	.0030
32	21121	Nov. 8	V slight.	V slight.	.07	6.20	.0016	.0012	.21	.0020	.0000	.00	3.1	.0010
23	21374	Nov. 26	Decided.	Heavy.	.09	5.90	.0006	.0010	.22	.0050	.0001	.02	2.5	.0030
33	21375	Nov. 26	Decided	Heavy.	.10	6.50	.0004	.0016	.22	.0070	.0000	.03	2.3	.0430
27	21376	Nov. 26	Decided.	Cons.	.10	5.90	.0006	.0020	.24	.0040	.0000	.02	2.3	.1200
24	21377	Nov. 26	Slight.	Slight.	.05	5.00	.0006	.0018	.20	.0030	.0000	.03	2.6	.0030
25	21378	Nov. 26	V. slight.	Slight.	.00	4.10	.0010	.0030	.21	.0040	.0000	.01	2.5	.0020
32	21379	Nov. 26	V. slight.	Slight.	.05	5.80	.0006	.0016	.19	.0030	.0000	.01	2.5	.0020
34	21380	Nov. 26	Decided.	Heavy.	.10	5.80	.0006	.0022	.22	.0050	.0001	.06	2.5	.3150
26	21382	Nov. 27	Slight.	Slight.	.40	6.90	.0026	.0048	.23	.0030	.0000	.21	3.5	.1150
40	21383	Nov. 27	Decided.	Heavy.	.17	7.30	.0010	.0014	.22	.0020	.0003	.05	2.7	.1350
28	21384	Nov. 27	Great	Heavy.	.40	11.60	.0024	.0030	.24	.0040	.0000	.28	3.0	.6000
21	21385	Nov. 27	Great.	Heavy.	.18	6.60	.0010	.0020	.27	.0140	.0001	.06	2.7	.5000
13	21386	Nov. 27	Decided.	Cons.	.41	6.40	.0030	.0042	.24	.0020	.0001	.13	2.7	.0850
11	21387	Nov. 27	Slight.	Cons.	.30	6.70	.0028	.0058	.24	.0030	.0001	.21	2.7	.0090
42	21388	Nov. 27	Slight.	Cons.	.40	7.50	.0038	.0042	.28	.0030	.0000	.20	3.3	.0800
49	21389	Nov. 27	V. slight.	Slight.	.02	5.30	.0008	.0020	.20	.0060	.0001	.03	2.6	.0020
48	21390	Nov. 27	Decided	Cons.	.18	6.60	.0010	.0014	.23	.0020	.0000	.04	2.9	.0250
41	21391	Nov. 27	Slight.	Cons.	.49	7.70	.0036	.0060	.22	.0040	.0000	.23	3.5	.1250
12*a*	21393	Nov. 27	V. great.	Heavy.	.13	8.70	.0022	.0028	.24	.0040	.0000	.04	3.1	.2250
12	21394	Nov. 27	V. slight.	Slight.	.06	5.80	.0016	.0028	.24	.0030	.0000	.07	3.4	.0030

Nos. 21382, 21383, 21386, 21388, 21390 and 21393 had a faint odor like sulphuretted hydrogen when collected; in Nos. 21387 and 21391 the odor was strong; the remaining samples had no odor. When received at the laboratory the odor of Nos. 21384 and 21387 was faintly earthy; of No. 21390, oily; of the others, none. A faintly earthy odor was developed in some of the samples on heating. —— The numbers of the wells from which the samples were collected are given in the left-hand column of the table. Nos. 21120 and 21121 were collected before the first pumping test was begun.

BILLERICA.

Chemical Examination of Water from Tubular Test Wells on the Westerly Side of the Concord River.

TABLE 4.

[Parts per 100,000.]

Number.	Date of Collection.	Appearance.			Residue on Evaporation.	Ammonia.		Chlorine.	Nitrogen as		Oxygen Consumed.	Hardness.	Iron.
		Turbidity.	Sediment.	Color.		Free.	Albuminoid		Nitrates.	Nitrites.			
	1897.												
21423	Dec. 3	None.	None.	.07	5.10	.0002	.0010	.24	.0060	.0000	.02	2.6	.0020
21449	Dec. 5	None.	None.	.05	5.00	.0002	.0018	.22	.0080	.0000	.01	2.9	.0020
21450	Dec. 4	None.	V. slight.	.02	5.00	.0002	.0016	.23	.0120	.0001	.02	2.7	.0020
21461	Dec. 6	None.	None.	.02	5.20	.0012	.0042	.24	.0080	.0000	.02	2.5	.0010
21478	Dec. 7	None.	None.	.04	6.00	.0004	.0032	.24	.0080	.0000	.04	2.6	.0020
21479	Dec. 7	None.	None.	.01	6.60	.0004	.0032	.24	.0080	.0000	.03	2.3	.0020
21490	Dec. 8	None.	None.	.05	5.50	.0002	.0024	.24	.0080	.0000	.03	2.3	.0000
21491	Dec. 8	None.	None.	.05	5.00	.0002	.0022	.24	.0080	.0000	.03	2.6	.0000
21492	Dec. 9	None.	None.	.05	4.90	.0002	.0022	.24	.0070	.0000	.04	2.7	.0010
21496	Dec. 10	None.	None.	.05	5.50	.0000	.0016	.25	.0080	.0000	.03	2.7	.0020
21497	Dec. 10	None.	None.	.05	5.40	.0000	.0016	.24	.0080	.0000	.03	2.7	.0020
21502	Dec. 11	None.	None.	.05	5.50	.0014	.0048	.24	.0080	.0000	.01	2.7	.0010

Odor, none. —— The samples were collected from the pipe discharging water from a steam pump while pumping from seven tubular wells, numbered 12*a*, 24, 25, 32, 34 and 53. The wells were located a short distance north of the Corner Bridge, the nearest well to the river being distant from it about 300 feet and the one farthest from the river about 700 feet. The test was begun on December 3, at 1.22 P.M., and pumping was continued until December 11, at 2 P.M.

BOSTON.

Water Supply of Boston.

Reservoir No. 5, in Southborough, which was under construction during the years 1894 to 1897, was taken by the Metropolitan Water Board Jan. 4, 1896. Storage in this reservoir was begun in the early part of the year, and a small amount of water from this source was used for the supply of Boston during the drier portion of the summer.

Sudbury River Supply — *Chemical Examination of Water from Indian Brook, at Head of Reservoir No. 6, Hopkinton.*

[Parts per 100,000.]

Number.	Date of Collection.	Appearance.			Residue on Evaporation.		Ammonia.				Chlorine.	Nitrogen as		Oxygen Consumed.	Hardness.
								Albuminoid.							
		Turbidity.	Sediment.	Color.	Total.	Loss on Ignition.	Free.	Total.	Dissolved.	Sus-pended		Nitrates.	Nitrites.		
	1897.														
18226	Jan. 11	None.	V. slight.	1.50	5.95	2.65	.0004	.0256	.0246	.0010	.42	.0020	.0002	1.82	1.3
18397	Feb. 1	None.	V. slight.	1.30	6.25	3.75	.0004	.0228	.0220	.0008	.50	.0130	.0001	1.23	1.7
18672	Mar. 1	None.	V. slight.	1.20	5.15	2.35	.0000	.0232	.0232	.0000	.49	.0030	.0000	1.18	1.1
18923	Mar 31	V. slight.	V. slight.	1.20	3.35	2.05	.0008	.0206	.0192	.0014	.32	.0020	.0000	0.97	0.8
19147	May 3	V. slight.	V. slight.	1.75	5.45	2.90	.0008	.0324	.0318	.0006	.46	.0030	.0000	1.48	1.4
19342	June 1	V. slight.	Slight.	2.30	5.80	3.80	.0014	.0426	.0402	.0024	.29	.0000	.0000	1.85	1.6
19686	July 1	None.	V. slight	2.42	6.90	4.10	.0014	.0452	.0424	.0028	.34	.0000	.0000	2.07	1.4
19957	Aug. 2	None.	V. slight.	3.20	8.05	4.60	.0008	.0556	.0550	.0006	.38	.0000	.0000	3.28	1.8
20334	Sept. 1	None.	V. slight.	2.00	7.00	4.00	.0014	.0418	.0414	.0004	.47	.0000	.0000	2.21	1.3
20691	Oct. 4	V. slight.	Slight.	0.70	6.60	3.55	.0010	.0398	.0382	.0016	.60	.0020	.0001	1.64	1.4
21012	Nov. 1	Slight.	Cons.	1.20	6.25	2.85	.0028	.0312	.0268	.0044	.70	.0150	.0001	1.01	1.6
21405	Dec. 1	None.	V. slight.	1.15	4.85	2.35	.0002	.0250	.0250	.0000	.47	.0030	.0000	0.87	1.6

Averages by Years.

-	1894	-	-	2.16	6.58	3.38	.0014	.0323	.0300	.0024	.54	.0018	.0000	1.78	1.6
-	1895	-	-	1.72	6.17	3.28	.0008	.0358	.0327	.0031	.56	.0029	.0000	1.84	1.6
-	1896	-	-	1.37	5.95	3.05	.0020	.0337	.0309	.0028	.50	.0039	.0001	1.52	1.3
-	1897	-	-	1.66	5.97	3.25	.0009	.0338	.0325	.0013	.45	.0036	.0000	1.63	1.4

Note to analyses of 1897: Odor, distinctly vegetable; in December, musty. —— The samples were collected from the brook, at its entrance to Reservoir No. 6.

BOSTON.

SUDBURY RIVER SUPPLY. — *Chemical Examination of Water from Reservoir No. 6, Ashland, collected near the Surface.*

[Parts per 100,000.]

Number.	Date of Collection.	Appearance.			Residue on Evaporation.		Ammonia.				Chlorine.	Nitrogen as		Oxygen Consumed.	Hardness.
								Albuminoid.							
		Turbidity.	Sediment.	Color.	Total.	Loss on Ignition.	Free.	Total.	Dissolved.	Sus-pended		Nitrates.	Nitrites.		
	1897.														
18227	Jan. 11	V. slight.	Slight.	0.95	5.65	2.00	.0016	.0336	.0302	.0034	.44	.0060	.0001	1.09	1.3
18398	Feb. 1	V. slight.	Slight.	1.10	5.10	2.45	.0010	.0212	.0210	.0002	.46	.0100	.0002	0.98	1.4
18673	Mar. 1	V. slight.	V. slight.	0.90	4.80	2.05	.0020	.0226	.0178	.0048	.45	.0120	.0000	0.81	1.1
18924	Mar. 31	Slight.	Slight.	0.75	3.80	1.60	.0016	.0208	.0166	.0042	.40	.0130	.0001	0.72	0.8
19148	May 3	V. slight.	V. slight.	0.73	3.95	1.80	.0026	.0172	.0166	.0006	.37	.0080	.0000	0.84	0.9
19343	June 1	V. slight.	V. slight.	0.63	3.65	1.55	.0044	.0168	.0146	.0022	.32	.0100	.0001	0.62	0.9
19687	July 1	V. slight	Slight.	0.92	4.00	1.70	.0016	.0210	.0198	.0012	.33	.0000	.0001	0.79	0.8
19958	Aug. 2	V slight.	V. slight.	0.67	3.85	1.75	.0020	.0224	.0206	.0018	.35	.0030	.0000	0.74	1.3
20335	Sept. 1	V. slight.	V. slight.	0.63	3.85	1.95	.0012	.0224	.0188	.0036	.30	.0000	.0000	0.41	0.8
20692	Oct. 4	V. slight.	V. slight.	0.62	3.70	1.80	.0014	.0230	.0212	.0018	.33	.0020	.0001	0.70	1.1
21013	Nov. 1	V. slight.	V. slight	0.52	3.75	1.85	.0020	.0214	.0194	.0020	.36	.0020	.0001	0.64	1.3
21406	Dec. 1	V. slight.	Slight.	0.71	4.05	1.75	.0014	.0226	.0204	.0022	.38	.0050	.0000	0.64	2.1

Averages by Years.

–	1894	–	–	0.79	3.93	1.59	.0013	.0191	.0166	.0025	.40	.0040	.0001	0.75	1.2
–	1895	–	–	0.73	4.15	1.86	.0017	.0239	.0210	.0029	.40	.0048	.0000	0.76	1.3
–	1896	–	–	0.64	3.86	1.74	.0017	.0208	.0175	.0033	.32	.0040	.0001	0.71	0.9
–	1897	–	–	0.76	4.18	1.85	.0019	.0221	.0198	.0023	.37	.0059	.0001	0.75	1.1

NOTE to analyses of 1897: Odor, generally distinctly vegetable; in December, faintly musty. The average amount of iron found in these samples was .0105 parts per 100,000. —— The samples were collected from the reservoir, near the dam. For monthly record of height of water in this reservoir, see table on page 135.

BOSTON.

SUDBURY RIVER SUPPLY. — *Microscopical Examination of Water from Reservoir No. 6, Ashland, collected near the Surface.*

[Number of organisms per cubic centimeter.]

	1897.											
	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
Day of examination,	12	3	2	1	4	2	3	3	2	5	2	2
Number of sample,	18227	18398	18673	18924	19148	19343	19687	19958	20335	20692	21013	21406
PLANTS.												
Diatomaceæ,	11	36	2	5	23	9	266	302	22	35	46	75
Asterionella,	0	0	2	0	8	0	0	0	0	0	13	51
Cyclotella,	4	16	0	1	4	3	120	145	2	0	1	11
Diatoma,	0	6	0	0	0	0	0	112	4	1	0	1
Tabellaria,	3	2	0	2	1	1	146	45	14	31	29	11
Cyanophyceæ,	0	0	0	0	0	0	0	0	42	6	0	5
Anabæna,	0	0	0	0	0	0	0	0	30	0	0	4
Clathrocystis,	0	0	0	0	0	0	0	0	12	6	0	1
Algæ,	0	0	1	0	0	0	32	63	90	99	8	34
Protococcus,	0	0	1	0	0	0	20	15	50	66	0	0
ANIMALS.												
Infusoria,	9	24	33	11	0	5	0	18	34	1	0	2
Dinobryon,	0	20	0	1	0	0	0	16	0	0	0	0
Peridinium,	9	4	32	10	0	2	0	2	34	1	0	0
Uroglena,	0	0	0	0	0	0	0	0	0	0	0	1
Vermes,	0	0	0	0	0	0	0	1	4	0	0	8
Miscellaneous, Zoöglœa,	10	40	40	15	5	0	0	5	15	10	3	15
TOTAL,	30	100	76	31	28	14	298	389	207	151	57	139

BOSTON.

SUDBURY RIVER SUPPLY.— *Chemical Examination of Water from Reservoir No. 6, Ashland, collected near the Bottom.*

[Parts per 100,000.]

Number.	Date of Collection.	Appearance.			Residue on Evaporation.		Ammonia.				Chlorine.	Nitrogen as		Oxygen Consumed.	Hardness.
								Albuminoid.							
		Turbidity.	Sediment.	Color.	Total.	Loss on Ignition.	Free.	Total.	Dissolved.	Suspended		Nitrates.	Nitrites.		
	1897.														
18228	Jan. 11	Slight.	Slight.	0.90	5.15	1.85	.0014	.0222	.0216	.0006	.44	.0080	.0001	1.17	1.3
18399	Feb. 1	V. slight.	Slight.	1.05	5.00	1.95	.0026	.0224	.0198	.0026	.46	.0150	.0001	0.98	1.4
18674	Mar. 1	V. slight.	V. slight.	1.10	5.10	2.10	.0034	.0252	.0224	.0028	.46	.0070	.0000	0.94	1.2
18925	Mar. 31	Slight.	V. slight.	0.85	3.60	1.75	.0020	.0202	.0196	.0006	.38	.0100	.0001	0.71	0.9
19149	May 3	V. slight	Slight.	0.70	4.00	1.60	.0010	.0160	.0160	.0000	.36	.0070	.0000	0.71	0.9
19344	June 1	V. slight.	V. slight	0.65	2.85	1.20	.0022	.0168	.0136	.0032	.32	.0080	.0000	0.62	0.9
19688	July 1	V. slight.	V. slight.	0.62	3.75	1.60	.0028	.0154	.0146	.0008	.34	.0030	.0001	0.78	0.8
19959	Aug. 2	V. slight.	V. slight.	0.46	3.65	1.60	.0026	.0168	.0158	.0010	.37	.0100	.0003	0.66	1.1
20336	Sept. 1	None.	V. slight.	0.48	3.75	1.50	.0006	.0136	.0116	.0020	.22	.0100	.0000	0.26	1.0
20693	Oct. 4	Slight.	V. slight.	0.53	3.95	1.90	.0032	.0186	.0168	.0018	.34	.0070	.0001	0.64	0.9
21014	Nov. 1	V. slight.	V. slight.	0.50	3.90	2.00	.0016	.0184	.0178	.0006	.37	.0030	.0001	0.66	1.0
21407	Dec. 1	V. slight.	Cons.	0.69	4.00	1.65	.0006	.0202	.0178	.0024	.39	.0060	.0000	0.64	2.1

Averages by Years.

-	1894*	-	-	1.01	4.08	1.73	.0032	.0175	.0149	.0026	.38	.0026	.0004	0.67	1.2
-	1895	-	-	0.75	4.33	1.94	.0036	.0204	.0181	.0023	.41	.0064	.0001	0.77	1.3
-	1896	-	-	0.63	3.82	1.75	.0013	.0189	.0164	.0025	.35	.0050	.0001	0.71	0.9
-	1897	-	-	0.71	4.06	1.72	.0020	.0188	.0173	.0015	.37	.0078	.0001	0.73	1.1

* April to December.

NOTE to analyses of 1897: Odor, generally distinctly vegetable. The average amount of iron found in these samples was .0134 parts per 100,000.——The samples were collected from the reservoir, near the dam. For monthly record of height of water in this reservoir, see table on page 135.

BOSTON.

SUDBURY RIVER SUPPLY. — *Chemical Examination of Water from Cold Spring Brook, at Head of Reservoir No. 4, Ashland.*

[Parts per 100,000.]

Number.	Date of Collection.	Appearance.			Residue on Evaporation.		Ammonia.				Chlorine.	Nitrogen as		Oxygen Consumed.	Hardness.
		Turbidity.	Sediment.	Color.	Total.	Loss on Ignition.	Free.	Albuminoid. Total.	Albuminoid. Dissolved.	Albuminoid. Suspended.		Nitrates.	Nitrites.		
	1897.														
18229	Jan. 11	V. slight.	V. slight.	1.35	5.90	2.40	.0008	.0296	.0286	.0010	.42	.0080	.0001	1.46	1.4
18410	Feb. 1	V. slight.	V. slight.	1.20	4.70	1.85	.0010	.0212	.0198	.0014	.36	.0100	.0000	0.88	1.3
18675	Mar. 1	V. slight.	Slight.	1.20	4.65	2.10	.0006	.0274	.0238	.0036	.34	.0070	.0000	1.04	1.1
18926	Mar. 31	V. slight.	V. slight.	1.05	3.25	1.55	.0000	.0218	.0206	.0012	.28	.0020	.0000	0.75	0.8
19152	May 3	V. slight.	V. slight.	1.60	4.95	2.65	.0014	.0346	.0324	.0022	.30	.0030	.0001	1.33	1.3
19350	June 1	V. slight.	Slight.	1.75	5.10	3.00	.0012	.0374	.0340	.0034	.18	.0030	.0000	1.18	0.8
19694	July 1	None.	Slight.	1.75	5.35	3.05	.0010	.0416	.0400	.0016	.27	.0000	.0000	1.35	1.1
19964	Aug. 2	V. slight.	Slight.	2.65	7.85	5.00	.0010	.0626	.0600	.0026	.29	.0020	.0000	3.16	1.7
20340	Sept. 1	V. slight.	V. slight.	1.25	5.20	2.85	.0018	.0326	.0284	.0042	.29	.0020	.0000	1.31	1.0
20697	Oct. 4	V. slight.	V. slight.	0.68	4.60	2.25	.0022	.0292	.0290	.0002	.33	.0000	.0001	0.95	1.1
21018	Nov. 1	V. slight.	V. slight.	1.10	5.35	2.80	.0006	.0312	.0234	.0078	.41	.0030	.0001	0.92	2.0
21412	Dec. 1	V. slight.	Slight.	1.26	5.50	2.90	.0010	.0298	.0278	.0020	.38	.0050	.0001	1.14	1.4

Averages by Years.

-	1889*	-	-	2.24	-	-	.0025	.0410	.0385	.0025	.28	.0056	.0001	-	-
-	1890	-	-	0.91	4.48	2.01	.0011	.0243	.0210	.0033	.24	.0090	.0001	-	1.5
-	1891	-	-	1.30	4.87	2.30	.0009	.0297	.0262	.0035	.23	.0087	.0001	-	1.3
-	1892	-	-	1.44	5.15	2.57	.0003	.0308	.0266	.0042	.25	.0068	.0001	-	1.2
-	1893	-	-	1.23	4.52	2.16	.0013	.0248	.0212	.0036	.26	.0031	.0001	0.98	1.3
-	1894	-	-	1.44	4.94	2.42	.0007	.0237	.0214	.0023	.31	.0043	.0000	1.20	1.2
-	1895	-	-	1.19	4.70	2.45	.0006	.0285	.0261	.0024	.32	.0034	.0000	1.16	1.2
-	1896	-	-	1.17	4.74	2.37	.0011	.0285	.0260	.0025	.26	.0034	.0000	1.21	1.0
-	1897	-	-	1.40	5.20	2.70	.0010	.0332	.0306	.0026	.32	.0037	.0000	1.29	1.2

* June to December.

NOTE to analyses of 1897: Odor, distinctly vegetable. —— The samples were collected from the brook, at its entrance into Reservoir No. 4.

BOSTON.

SUDBURY RIVER SUPPLY. — *Chemical Examination of Water from Reservoir No. 4, Ashland.*

[Parts per 100,000.]

Number.	Date of Collection.	Appearance.			Residue on Evaporation.		Ammonia.				Chlorine.	Nitrogen as		Oxygen Consumed.	Hardness.
		Turbidity.	Sediment.	Color.	Total.	Loss on Ignition.	Free.	Albuminoid. Total.	Albuminoid. Dissolved.	Albuminoid. Suspended		Nitrates.	Nitrites.		
	1897.														
18230	Jan. 11	V. slight.	V. slight.	0.75	4.60	1.70	.0018	.0236	.0224	.0012	.39	.0030	.0002	0.95	1.3
18411	Feb. 1	Slight.	Slight.	1.15	5.45	2.20	.0016	.0334	.0306	.0028	.34	.0070	.0001	1.10	1.3
18676	Mar. 1	V. slight.	Slight.	1.05	4.20	1.85	.0018	.0244	.0218	.0026	.34	.0050	.0000	0.85	1.3
18927	Mar. 31	Slight.	V. slight.	1.00	4.00	1.65	.0010	.0212	.0212	.0000	.33	.0030	.0000	0.75	0.8
19153	May 3	V. slight.	V. slight.	0.95	4.05	2.05	.0020	.0242	.0234	.0008	.31	.0030	.0000	0.68	1.3
19351	June 1	V. slight.	V. slight.	0.95	4.05	1.85	.0018	.0266	.0242	.0024	.24	.0030	.0000	0.78	0.6
19695	July 1	None.	V. slight.	1.02	3.80	1.85	.0030	.0230	.0214	.0016	.26	.0000	.0000	0.85	0.8
19965	Aug. 2	V. slight.	V. slight.	0.66	3.65	1.65	.0004	.0242	.0210	.0032	.29	.0000	.0000	0.74	1.0
20341	Sept. 1	V. slight.	V. slight.	0.64	3.70	1.80	.0010	.0210	.0200	.0010	.26	.0000	.0000	0.78	0.8
20698	Oct. 4	V. slight.	V. slight.	0.68	3.70	1.45	.0018	.0198	.0198	.0000	.28	.0020	.0001	0.66	1.1
21019	Nov. 1	V. slight.	V. slight.	0.51	3.65	1.85	.0024	.0248	.0190	.0058	.30	.0030	.0001	0.64	1.3
21413	Dec. 1	Slight.	Cons.	0.70	3.95	1.85	.0014	.0244	.0236	.0008	.33	.0040	.0001	0.67	1.4

Averages by Years.

-	1888	-	-	0.72	3.83	1.70	.0007	.0277	-	-	.22	.0054	.0001	-	-
-	1889	-	-	0.85	3.48	1.50	.0016	.0251	.0218	.0033	.23	.0068	.0002	-	-
-	1890	-	-	0.61	3.67	1.40	.0008	.0222	.0191	.0031	.24	.0096	.0001	-	1.7
-	1891	-	-	0.53	3.24	1.55	.0006	.0187	.0156	.0031	.20	.0062	.0001	-	0.9
-	1892	-	-	0.64	3.60	1.52	.0002	.0200	.0168	.0032	.23	.0061	.0001	-	1.1
-	1893	-	-	0.77	3.54	1.63	.0024	.0206	.0173	.0033	.23	.0048	.0001	0.68	1.0
-	1894	-	-	0.83	4.00	1.73	.0027	.0202	.0180	.0022	.29	.0045	.0001	0.78	1.1
-	1895	-	-	0.89	4.22	2.04	.0015	.0246	.0223	.0023	.32	.0052	.0000	0.90	1.1
-	1896	-	-	0.75	3.90	1.86	.0008	.0239	.0210	.0029	.27	.0024	.0000	0.91	0.9
-	1897	-	-	0.84	4.07	1.81	.0017	.0242	.0224	.0018	.31	.0027	.0000	0.79	1.1

NOTE to analyses of 1897: Odor, distinctly vegetable. The iron was determined in eleven samples, the average amount in parts per 100,000 being .0095. —— The samples were collected from the reservoir, near the gate-house. No. 19965 was collected 8 feet beneath the surface, and the others 1 foot beneath the surface. For monthly record of height of water in this reservoir, see table on page 135.

BOSTON.

Sudbury River Supply. — *Microscopical Examination of Water from Reservoir No. 4, Ashland.*

[Number of organisms per cubic centimeter.]

	1897.											
	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
Day of examination,	12	4	2	1	4	2	3	3	2	5	2	2
Number of sample,	18230	18411	18676	18927	19153	19351	19695	19965	20341	20698	21019	21413
PLANTS.												
Diatomaceæ,	1	14	4	28	44	447	57	20	28	4	21	45
Cyclotella,	1	14	2	0	16	436	42	14	24	2	3	5
Algæ,	1	6	6	2	0	21	0	326	86	69	19	7
Protococcus,	1	6	6	2	0	13	0	74	48	8	8	7
Raphidium,	0	0	0	0	0	8	0	8	8	61	11	0
Staurogenia,	0	0	0	0	0	0	0	244	0	0	0	0
ANIMALS.												
Rhizopoda,	0	0	0	0	0	0	6	2	0	1	1	0
Infusoria,	0	2	0	2	2	0	2	0	0	0	0	4
Uroglena,	0	0	0	1	0	0	0	0	0	0	0	0
Vermes, Asplanchna,	0	0	0	0	0	0	0	6	0	0	0	0
Crustacea, Daphnia,	0	0	0	0	0	pr.	0	0	0	0	0	0
Miscellaneous, Zoöglœa,	0	15	0	0	0	0	5	5	10	5	3	0
Total,	2	37	10	32	46	468	70	359	124	79	44	56

BOSTON.

SUDBURY RIVER SUPPLY.— *Chemical Examination of Water from Reservoir No. 4, collected near the Bottom.*

[Parts per 100,000.]

Number.	Date of Collection.	Appearance.			Residue on Evaporation.		Ammonia.				Chlorine.	Nitrogen as		Oxygen Consumed.	Hardness.
								Albuminoid.							
		Turbidity.	Sediment.	Color.	Total.	Loss on Ignition.	Free.	Total.	Dissolved.	Sus-pended		Nitrates.	Nitrites.		
	1897.														
18231	Jan. 11	Slight.	V. slight.	1.10	5.70	2.30	.0020	.0282	.0268	.0014	.45	.0030	.0001	0.88	1.3
18412	Feb. 1	V. slight.	Slight.	1.10	5.30	2.20	.0016	.0298	.0280	.0018	.34	.0050	.0001	1.09	1.3
18677	Mar. 1	V. slight.	Slight.	1.10	5.15	2.40	.0048	.0260	.0240	.0020	.34	.0050	.0000	1.02	1.5
18928	Mar. 31	V slight	V. slight.	1.00	3.90	1.85	.0016	.0204	.0196	.0008	.32	.0050	.0001	0.78	0.8
19154	May 3	V. slight.	V. slight.	0.93	4.30	2.00	.0024	.0200	.0200	.0000	.30	.0050	.0000	0.80	1.3
19352	June 1	V. slight.	V. slight.	0.95	3.85	1.85	.0024	.0228	.0176	.0052	.24	.0070	.0000	0.70	1.6
19696	July 1	None.	V. slight.	0.88	3.80	1.85	.0034	.0200	.0182	.0018	.26	.0030	.0003	0.82	0.8
19966	Aug. 2	V. slight.	V. slight.	0.66	3.90	1.70	.0006	.0190	.0164	.0026	.29	.0070	.0000	0.72	1.3
20342	Sept. 1	V. slight.	V. slight.	0.63	3.85	1.80	.0012	.0196	.0172	.0024	.28	.0070	.0000	0.69	0.8
20699	Oct. 4	V. slight.	V. slight.	0.68	3.85	1.60	.0032	.0178	.0178	.0000	.27	.0030	.0002	0.66	1.3
21020	Nov. 1	V. slight.	V. slight.	0.59	3.85	1.85	.0020	.0210	.0210	.0000	.31	.0030	.0001	0.59	1.1
21414	Dec. 1	Slight.	Cons.	0.70	4.15	1.90	.0014	.0228	.0216	.0012	.32	.0030	.0001	0.67	1.6

Averages by Years.

-	1888	-	-	0.72	4.02	1.70	.0025	.0261	-	-	.23	.0059	.0001	-	-
-	1889	-	-	0.86	3.55	1.49	.0023	.0224	.0198	.0026	.22	.0086	.0002	-	-
-	1890	-	-	0.66	3.97	1.54	.0017	.0199	.0168	.0031	.23	.0120	.0001	-	1.6
-	1892*	-	-	0.48	3.45	1.45	.0002	.0142	.0108	.0034	.26	.0100	.0001	-	1.3
-	1893†	-	-	0.86	4.15	1.77	.0024	.0187	.0162	.0025	.28	.0125	.0000	0.74	1.4
-	1895‡	-	-	0.80	4.07	1.57	.0020	.0197	.0183	.0014	.30	.0060	.0000	0.82	1.1
-	1896	-	-	0.73	4.07	1.89	.0012	.0213	.0186	.0027	.26	.0039	.0000	0.88	1.0
-	1897	-	-	0.86	4.30	1.94	.0022	.0223	.0207	.0016	.31	.0047	.0001	0.78	1.2

* September. † February and September. ‡ July and August.

NOTE to analyses of 1897: Odor, distinctly vegetable. The average amount of iron found in these samples was .0113 parts per 100,000.——The samples were collected from the reservoir, near the gatehouse. For monthly record of height of water in this reservoir, see table on page 135.

BOSTON.

SUDBURY RIVER SUPPLY.— *Chemical Examination of Water from Sudbury River, at Head of Reservoir No. 2, Ashland.*

[Parts per 100,000.]

Number.	Date of Collection.	Appearance.			Residue on Evaporation.		Ammonia.				Chlorine.	Nitrogen as		Oxygen Consumed.	Hardness.
		Turbidity.	Sediment.	Color.	Total.	Loss on Ignition.	Free.	Albuminoid. Total.	Albuminoid. Dissolved.	Albuminoid. Suspended		Nitrates.	Nitrites.		
	1897.														
18232	Jan. 11	V. slight.	V. slight.	1.00	5.70	2.30	.0012	.0230	.0212	.0018	.46	.0130	.0002	0.80	1.4
18415	Feb. 1	V. slight.	Slight.	0.90	5.25	1.65	.0000	.0172	.0156	.0016	.40	.0170	.0000	0.72	1.4
18678	Mar. 1	V. slight.	V. slight.	0.95	4.65	1.85	.0006	.0222	.0202	.0020	.36	.0120	.0000	0.81	1.4
18929	Mar. 31	V. slight.	Slight.	0.75	3.25	1.40	.0006	.0184	.0144	.0040	.28	.0050	.0001	0.67	0.6
19155	May 3	V. slight.	Slight.	1.05	4.45	2.25	.0014	.0306	.0288	.0018	.30	.0070	.0001	0.90	1.1
19353	June 1	V. slight.	Slight.	1.30	4.75	2.25	.0032	.0302	.0284	.0018	.21	.0070	.0000	1.08	1.3
19697	July 1	None.	Slight.	1.28	4.65	2.30	.0014	.0254	.0234	.0020	.27	.0030	.0001	1.02	0.9
19969	Aug. 2	Slight.	V. slight.	2.20	7.45	4.75	.0022	.0474	.0440	.0034	.34	.0030	.0000	2.20	1.6
20343	Sept. 1	None.	Slight.	1.45	5.60	2.55	.0016	.0318	.0272	.0046	.33	.0030	.0000	1.30	1.3
20700	Oct. 4	V. slight.	Slight.	1.00	3.70	1.75	.0016	.0266	.0220	.0046	.28	.0050	.0001	0.90	0.8
21021	Nov. 1	V. slight.	V. slight.	0.60	4.20	1.90	.0014	.0180	.0178	.0002	.38	.0000	.0001	0.62	1.3
21415	Dec. 1	Slight.	Cons.	1.00	4.35	2.20	.0008	.0262	.0232	.0030	.39	.0070	.0001	0.91	1.4

Averages by Years.

-	1888	-	-	1.19	4.76	2.07	.0018	.0293	-	-	.29	.0108	.0002	-	-
-	1889	-	-	1.25	3.62	1.38	.0013	.0294	.0267	.0027	.30	.0080	.0002	-	-
-	1890	-	-	0.82	5.18	2.09	.0014	.0256	.0220	.0036	.30	.0135	.0001	-	1.7
-	1891	-	-	0.88	4.35	1.81	.0008	.0274	.0236	.0038	.26	.0112	.0001	-	1.1
-	1892	-	-	1.00	4.71	2.08	.0006	.0247	.0214	.0033	.28	.0099	.0001	-	1.3
-	1893	-	-	0.99	4.57	2.03	.0019	.0232	.0196	.0036	.34	.0068	.0001	0.82	1.4
-	1894	-	-	1.31	4.68	2.17	.0007	.0231	.0211	.0020	.34	.0059	.0001	1.06	1.2
-	1895	-	-	1.07	4.71	2.20	.0014	.0301	.0276	.0025	.36	.0086	.0001	0.99	1.1
-	1896	-	-	0.85	4.13	1.86	.0012	.0244	.0219	.0025	.29	.0058	.0001	0.92	0.9
-	1897	-	-	1.12	4.83	2.26	.0013	.0264	.0238	.0026	.33	.0068	.0001	0.99	1.2

NOTE to analyses of 1897: Odor, distinctly vegetable.—— The samples were collected from the river, near the old dam at the upper end of Reservoir No. 2, at a depth of 1 foot beneath the surface.

BOSTON.

SUDBURY RIVER SUPPLY. — *Chemical Examination of Water from Reservoir No. 2, Framingham.*

[Parts per 100,000.]

Number.	Date of Collection.	Appearance.			Residue on Evaporation.		Ammonia.				Chlorine.	Nitrogen as		Oxygen Consumed.	Hardness.
		Turbidity.	Sediment.	Color.	Total.	Loss on Ignition.	Free.	Albuminoid.				Nitrates.	Nitrites.		
								Total.	Dissolved.	Suspended.					
	1897.														
18233	Jan. 11	Slight.	V. slight.	0.80	5.40	2.10	.0036	.0182	.0162	.0020	.46	.0180	.0001	0.73	1.4
18416	Feb. 1	V. slight.	V. slight.	0.88	5.00	1.80	.0006	.0160	.0158	.0002	.38	.0250	.0001	0.70	1.1
18679	Mar. 1	V. slight.	V. slight.	0.90	4.25	1.60	.0006	.0214	.0186	.0028	.31	.0150	.0000	0.79	1.5
18930	Mar. 31	V. slight	Slight.	0.72	3.10	1.35	.0004	.0164	.0148	.0016	.24	.0070	.0000	0.67	0.8
19156	May 3	V. slight.	V. slight.	0.90	4.00	1.65	.0010	.0208	.0196	.0012	.31	.0070	.0001	0.73	1.1
19354	June 1	V. slight.	Slight.	1.10	4.50	2.25	.0024	.0278	.0232	.0046	.25	.0050	.0000	0.97	1.1
19698	July 1	V. slight.	Slight.	1.32	4.65	2.30	.0010	.0282	.0262	.0020	.27	.0050	.0001	1.14	0.9
19970	Aug. 2	Slight.	V. slight.	1.08	4.70	2.30	.0008	.0342	.0300	.0042	.29	.0050	.0000	1.14	1.0
20344	Sept. 1	Slight.	Slight.	1.05	5.35	2.80	.0016	.0388	.0320	.0068	.31	.0050	.0000	1.38	1.1
20701	Oct. 4	Slight.	V. slight.	0.93	4.25	1.85	.0012	.0290	.0290	.0000	.30	.0030	.0001	0.77	0.8
21022	Nov. 1	V. slight.	V. slight.	0.65	4.05	2.05	.0014	.0252	.0248	0004	.34	.0030	.0001	0.90	1.0
21416	Dec. 1	V. slight.	Cons.	1.15	5.10	2.45	.0012	.0270	.0252	.0018	.42	.0070	.0001	0.94	1.7

Averages by Years.

-	1888	-	-	1.08	4.63	2.01	.0005	.0300	-	-	.30	.0102	.0001	-	-
-	1889	-	-	1.04	3.42	1.26	.0015	.0296	.0252	.0044	.29	.0075	.0002	-	-
-	1890	-	-	0.77	4.58	1.83	.0010	.0235	.0191	.0044	.28	.0128	.0001	-	1.7
-	1891	-	-	0.72	4.02	1.68	.0004	.0230	.0194	.0036	.24	.0105	.0001	-	1.0
-	1892	-	-	0.89	4.35	1.92	.0004	.0231	.0192	.0039	.29	.0082	.0001	-	1.3
-	1893	-	-	0.98	4.28	1.86	.0010	.0219	.0190	.0029	.31	.0054	.0001	0.81	1.2
-	1894	-	-	1.12	4.36	2.05	.0008	.0216	.0193	.0023	.33	.0058	.0000	0.93	1.3
-	1895	-	-	1.03	4.65	2.05	.0015	.0244	.0211	.0033	.34	.0090	.0001	0.98	1.2
-	1896	-	-	0.74	4.08	1.87	.0011	.0233	.0200	.0033	.30	.0051	.0001	0.84	0.9
-	1897	-	-	0.96	4.53	2.04	.0013	.0252	.0229	.0023	.32	.0087	.0001	0.89	1.1

NOTE to analyses of 1897: Odor, distinctly vegetable. —— The samples were collected from the reservoir, near the gate-house, at a depth of 8 feet beneath the surface. For monthly record of height of water in this reservoir, see table on page 135.

BOSTON.

SUDBURY RIVER SUPPLY.—*Microscopical Examination of Water from Reservoir No. 2, Framingham.*

[Number of organisms per cubic centimeter.]

	1897.											
	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
Day of examination,	12	4	3	1	5	3	3	3	2	5	2	2
Number of sample,	18233	18416	18679	18930	19156	19354	19698	19970	20344	20701	21022	21416
PLANTS.												
Diatomaceæ,	5	7	3	1	252	380	20	22	288	172	125	21
Cyclotella,	0	0	0	0	0	364	14	4	10	16	5	0
Diatoma,	0	0	0	0	0	0	0	16	268	0	0	0
Melosira,	0	0	0	0	0	6	0	0	0	128	108	3
Synedra,	3	2	0	0	220	2	3	2	6	28	10	2
Cyanophyceæ, Clathrocystis,	0	0	0	0	0	0	0	0	6	0	0	0
Algæ,	0	2	0	0	2	26	4	106	66	34	0	0
Protococcus,	0	2	0	0	2	10	4	78	34	16	0	0
ANIMALS.												
Rhizopoda, Actinophrys,	0	0	0	0	0	0	0	0	8	0	1	3
Infusoria,	0	0	8	0	4	17	0	0	6	6	0	1
Zoöthamnium,	0	0	0	0	0	17	0	0	0	0	0	0
Vermes,	0	0	0	0	0	0	0	0	2	0	2	0
Crustacea, Cyclops,	0	0	0	0	0	0	0	0	pr.	0	0	0
Miscellaneous, Zoöglœa,	10	20	10	40	40	25	60	5	60	15	3	0
TOTAL,	15	29	21	41	298	448	84	133	436	227	131	25

BOSTON.

SUDBURY RIVER SUPPLY. — *Chemical Examination of Water from Walker's Brook, Marlborough.*

[Parts per 100,000.]

Number.	Date of Collection.	Appearance.			Residue on Evaporation.		Ammonia.				Chlorine.	Nitrogen as		Oxygen Consumed.	Hardness.
		Turbidity.	Sediment.	Color.	Total.	Loss on Ignition.	Free.	Albuminoid. Total.	Albuminoid. Dissolved.	Albuminoid. Suspended.		Nitrates.	Nitrites.		
	1897.														
18244	Jan. 12	Distinct.	Slight.	0.40	16.10	3.00	.0710	.0222	.0216	.0006	2.69	.2100	.0022	0.43	4.7
18401	Feb. 1	Slight.	Cons., earthy.	0.35	14.30	5.00	.1632	.0240	.0176	.0064	1.93	.1600	.0026	0.42	4.9
18668	Mar. 1	Slight.	Slight.	0.53	14.70	4.30	.1536	.0196	.0184	.0012	2.03	.1560	.0018	0.58	5.1
18919	Mar. 31	Slight.	Slight.	0.70	12.15	3.75	.0928	.0238	.0228	.0010	1.66	.1800	.0014	0.60	4.7
19144	May 3	Distinct, clayey.	Cons.	1.25	13.00	3.30	.0358	.0426	.0382	.0044	1.44	.1150	.0019	1.15	4.9
19341	June 1	V. slight.	Slight.	0.92	10.70	2.60	.0524	.0298	.0276	.0022	1.81	.1050	.0012	0.67	5.1
19685	July 1	Distinct.	Cons.	1.18	15.20	4.40	.0384	.0358	.0326	.0032	1.67	.0850	.0072	0.86	5.3
19975	Aug. 2	Slight.	Slight.	1.55	17.85	5.80	.0326	.0526	.0482	.0044	1.78	.1200	.0130	1.72	6.4
20332	Sept. 1	V. slight.	V. slight.	0.42	16.75	4.10	.0082	.0192	.0180	.0012	2.19	.1440	.0160	0.56	6.7
20707	Oct. 4	V. slight.	V. slight.	0.20	17.85	5.00	.0354	.0104	.0096	.0008	2.36	.2200	.0112	0.22	6.4
21007	Nov. 1	V. slight.	V. slight.	0.16	11.45	4.65	.0374	.0124	.0124	.0000	2.31	.1700	.0055	0.16	6.4
21401	Dec. 1	Slight.	Slight.	0.96	16.40	4.45	.0940	.0298	.0274	.0024	2.20	.1880	.0026	0.74	6.7

Averages by Years.

-	1892	-	-	0.49	16.84	4.35	.0307	.0274	.0225	.0048	2.58	.2975	.0037	-	5.7
-	1893	-	-	0.38	14.05	3.94	.0337	.0257	.0180	.0077	1.96	.1878	.0020	0.39	5.2
-	1894	-	-	0.46	14.14	3.62	.0371	.0217	.0171	.0046	2.08	.1888	.0018	0.47	4.9
-	1895	-	-	0.57	14.71	3.79	.0292	.0256	.0214	.0042	2.04	.1768	.0035	0.58	5.1
-	1896	-	-	0.63	14.58	3.97	.0435	.0290	.0236	.0054	1.99	.1576	.0043	0.68	5.0
-	1897	-	-	0.72	14.70	4.20	.0679	.0268	.0245	.0023	2.01	.1544	.0055	0.68	5.6

NOTE to analyses of 1897: Odor, generally distinctly vegetable and musty, becoming stronger on heating. —— The samples were collected from the brook at the first road bridge below Maple Street, about 1 mile south of the centre of the city of Marlborough.

BOSTON.

SUDBURY RIVER SUPPLY. — *Chemical Examination of Water from Reservoir No. 5, Southborough, collected near the Surface.*

[Parts per 100,000.]

Number.	Date of Collection.	Appearance.			Residue on Evaporation.		Ammonia.				Chlorine.	Nitrogen as		Oxygen Consumed.	Hardness.
		Turbidity.	Sediment.	Color.	Total.	Loss on Ignition.	Free.	Albuminoid. Total.	Albuminoid. Dissolved.	Albuminoid. Sus-pended.		Nitrates.	Nitrites.		
	1897.														
18649	Feb. 24	Distinct, clayey.	Slight.	.77	6.30	2.55	.0236	.0286	.0256	.0030	.41	.0300	.0003	.63	1.8
18771	Mar. 15	Distinct, clayey.	Cons., sandy.	.85	5.90	1.80	.0260	.0286	.0268	.0018	.40	.0350	.0003	.62	1.4
18935	Mar. 31	Distinct.	Cons., earthy.	.60	4.95	1.85	.0260	.0274	.0210	.0064	.35	.0280	.0003	.60	1.4
19179	May 6	V. slight.	V. slight.	.60	4.65	1.70	.0048	.0262	.0180	.0082	.36	.0280	.0005	.62	1.9
19362	June 1	V slight.	Slight.	.50	5.05	1.50	.0076	.0202	.0192	.0010	.33	.0080	.0002	.52	1.9
19690	July 1	V. slight.	V. slight	.92	5.70	2.00	.0090	.0266	.0214	.0052	.35	.0100	.0002	.71	1.8
19976	Aug. 2	V. slight	V. slight.	.64	5.70	2.30	.0030	.0274	.0252	.0022	.36	.0200	.0005	.66	2.0
20349	Sept. 1	V. slight.	V. slight.	.60	5.90	2.00	.0014	.0256	.0218	.0038	.37	.0100	.0002	.63	2.0
20694	Oct. 4	Slight.	Slight.	.51	5.95	2.10	.0038	.0246	.0246	.0000	.39	.0080	.0001	.58	2.1
21015	Nov. 1	V. slight.	V. slight.	.45	6.20	2.10	.0030	.0240	.0240	.0000	.44	.0050	.0001	.54	2.2
21409	Dec. 1	Decided.	Cons.	.49	6.40	1.85	.0032	.0256	.0228	.0028	.48	.0100	.0002	.53	3.1
Av.	....	....	....	.63	5.70	1.98	.0101	.0259	.0228	.0031	.39	.0175	.0003	.60	2.0

Odor, vegetable, and sometimes mouldy, becoming somewhat stronger on heating. The average amount of iron in these samples was .0142 parts per 100,000. —— The samples were collected from the reservoir near the gate house, at a depth of 1 foot beneath the surface. For monthly record of height of water in this reservoir, see table on page 135. The quality of the water of this source may have been affected during much of the year by work incident to the completion of the reservoir.

SUDBURY RIVER SUPPLY. — *Microscopical Examination of Water from Reservoir No. 5, Southborough, collected near the Surface.*

[Number of organisms per cubic centimeter.]

	1897. Feb.	Mar.	Apr.	May.	June	July.	Aug	Sept.	Oct.	Nov.	Dec.
Day of examination,	27	16	2	7	3	3	4	2	5	2	2
Number of sample,	18649	18771	18935	19179	19362	19690	19976	20349	20694	21015	21409
PLANTS.											
Diatomaceæ,	**2**	**1**	**3**	**486**	**6**	**1**	**14**	**6**	**148**	**546**	**498**
Asterionella,	0	0	0	126	0	0	0	0	8	544	496
Cyclotella,	0	0	0	0	0	0	0	2	80	0	0
Synedra,	2	1	2	344	1	1	10	4	60	1	2
Cyanophyceæ,	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**63**	**16**	**0**	**2**
Anabæna,	0	0	0	0	0	0	0	63	8	0	2
Algæ,	**0**	**0**	**1**	**0**	**1**	**1**	**414**	**29**	**42**	**25**	**26**
Protococcus,	0	0	1	0	1	1	372	29	0	0	10

BOSTON.

SUDBURY RIVER SUPPLY. — *Microscopical Examination of Water from Reservoir No. 5, Southborough, collected near the Surface* — Concluded.

[Number of organisms per cubic centimeter.]

	1897.										
	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov	Dec.
ANIMALS.											
Rhizopoda, Actinophrys, ...	0	0	0	0	0	0	0	0	4	1	0
Infusoria, ...	2	1	2	21	0	0	2	0	2	0	4
Dinobryon, ...	0	0	0	12	0	0	0	0	0	0	0
Synura, ...	0	0	0	8	0	0	0	0	0	0	0
Vermes, ...	0	0	0	0	1	0	0	1	0	0	2
Crustacea, ...	0	0	0	pr.	pr.	pr.	0	0	0	0	0
Miscellaneous, Zoöglœa, ...	0	0	0	40	0	0	8	20	15	3	15
TOTAL, ...	4	2	6	547	8	2	438	119	227	575	547

SUDBURY RIVER SUPPLY. — *Chemical Examination of Water from Reservoir No. 5, Southborough, collected about Midway between the Surface and Bottom.*

[Parts per 100,000.]

Number.	Date of Collection.	Appearance.			Residue on Evaporation.		Ammonia.				Chlorine.	Nitrogen as		Oxygen Consumed.	Hardness.
								Albuminoid.							
		Turbidity.	Sediment.	Color.	Total.	Loss on Ignition.	Free.	Total.	Dissolved.	Sus-pended.		Nitrates.	Nitrites.		
	1897.														
18650	Feb. 24	Distinct, clayey.	Slight.	0.75	5.80	1.90	.0234	.0280	.0258	.0022	.40	.0300	.0001	.68	1.9
18772	Mar. 15	Distinct, clayey.	Cons., sandy.	0.80	6.05	1.95	.0260	.0286	.0252	.0034	.40	.0280	.0003	.66	1.4
18937	Mar. 31	Distinct.	Cons.	0.65	5.00	1.55	.0250	.0280	.0214	.0066	.34	.0300	.0003	.60	1.4
19150	May 3	V. slight.	Slight, sandy.	0.60	5.25	1.50	.0050	.0252	.0184	.0068	.35	.0250	.0004	.65	1.7
19363	June 1	V. slight.	V. slight.	0.55	5.00	1.70	.0068	.0206	.0154	.0052	.38	.0200	.0005	.52	1.9
19691	July 1	V. slight.	Slight.	0.68	5.25	2.00	.0088	.0208	.0190	.0018	.37	.0070	.0002	.61	1.7
19977	Aug. 2	V. slight.	V. slight.	0.63	5.90	2.30	.0058	.0248	.0228	.0020	.36	.0100	.0006	.66	1.8
20350	Sept. 1	V. slight.	V. slight.	0.62	5.95	2.00	.0026	.0226	.0200	.0026	.36	.0080	.0004	.65	2.1
20695	Oct. 4	Slight.	Slight.	1.00	6.10	2.30	.0032	.0254	.0234	.0020	.39	.0070	.0001	.61	2.1
21016	Nov. 1	V. slight.	V. slight.	0.48	6.15	1.95	.0016	.0262	.0232	.0030	.44	.0050	.0001	.55	3.5
21410	Dec. 1	Decided.	Cons.	0.60	6.50	1.85	.0028	.0244	.0238	.0006	.46	.0120	.0002	.49	2.5
Av...	....	....	....	0.67	5.72	1.91	.0101	.0250	.0217	.0033	.39	.0165	.0003	.61	2.0

Odor, faintly vegetable, becoming stronger on heating. The iron was determined in five samples, the average amount in parts per 100,000 being .0152. —— The samples were collected from the reservoir, near the gate-house, at depths ranging from 14 to 22 feet beneath the surface. For monthly record of height of water in this reservoir, see table on page 135.

BOSTON.

SUDBURY RIVER SUPPLY.— *Chemical Examination of Water from Reservoir No. 5, Southborough, collected near the Bottom.*

[Parts per 100,000.]

Number.	Date of Collection.	Appearance.			Residue on Evaporation.		Ammonia.				Chlorine.	Nitrogen as		Oxygen Consumed.	Hardness.
		Turbidity.	Sediment.	Color.	Total.	Loss on Ignition.	Free.	Albuminoid. Total.	Albuminoid. Dissolved.	Albuminoid. Suspended.		Nitrates.	Nitrites.		
	1897.														
18648	Feb. 24	Distinct, clayey.	Slight.	.80	5.95	2.05	.0236	.0246	.0212	.0034	.37	.0370	.0003	.71	1.7
18773	Mar. 15	Distinct, clayey.	Cons., sandy.	.75	5.85	1.90	.0248	.0284	.0268	.0016	.39	.0280	.0005	.67	1.4
18936	Mar. 31	Distinct.	Cons.	.68	4.95	1.65	.0254	.0278	.0206	.0072	.35	.0280	.0003	.58	1.4
19151	May 3	V. slight.	Slight.	.52	5.35	2.15	.0156	.0262	.0228	.0034	.34	.0250	.0004	.58	1.7
19364	June 1	Slight.	Slight.	.53	5.15	2.20	.0224	.0224	.0188	.0036	.33	.0200	.0005	.53	1.9
19692	July 1	V. slight.	Slight.	.70	5.35	2.10	.0144	.0228	.0196	.0032	.37	.0100	.0006	.59	1.7
19978	Aug. 2	V. slight.	V. slight.	.60	5.60	2.25	.0024	.0242	.0204	.0038	.40	.0250	.0000	.62	1.8
20351	Sept. 1	Distinct.	Slight.	.84	6.05	2.20	.0068	.0244	.0218	.0026	.36	.0120	.0005	.59	2.0
20696	Oct. 4	Slight.	Slight.	.67	6.10	2.15	.0026	.0280	.0224	.0056	.39	.0080	.0001	.60	2.1
21017	Nov. 1	V. slight.	Slight.	.47	6.35	2.25	.0030	.0250	.0224	.0026	.44	.0050	.0001	.54	2.7
21411	Dec. 1	Decided.	Heavy.	.55	6.60	2.00	.0024	.0252	.0232	.0020	.52	.0130	.0002	.50	3.3
Av...	....	....	....	.65	5.75	2.08	.0130	.0254	.0218	.0036	.39	.0192	.0003	.59	2.0

Odor, generally faintly vegetable, becoming somewhat stronger on heating. The average amount of iron found in these samples was .0206 parts per 100,000.—— The samples were collected from the reservoir, near the gate-house. For monthly record of height of water in this reservoir, see table on page 135.

BOSTON.

SUDBURY RIVER SUPPLY. — *Chemical Examination of Water from Stony Brook, at Head of Reservoir No. 3, Southborough.*

[Parts per 100,000.]

Number.	Date of Collection.	Appearance.			Residue on Evaporation.		Ammonia.				Chlorine.	Nitrogen as		Oxygen Consumed.	Hardness.
		Turbidity.	Sediment.	Color.	Total.	Loss on Ignition.	Free.	Albuminoid. Total.	Albuminoid. Dissolved.	Albuminoid. Suspended		Nitrates.	Nitrites.		
	1897.														
18234	Jan. 11	Decided, clayey.	Cons.	1.15	10.85	2.80	.0140	.0290	.0242	.0048	.55	.0500	.0003	0.91	2.5
18413	Feb. 1	Distinct.	Cons.	0.52	7.75	2.05	.0350	.0384	.0380	.0004	.61	.0400	.0004	0.61	2.3
18680	Mar. 1	Slight, milky.	Slight.	0.12	8.95	2.15	.0128	.0184	.0144	.0040	.52	.1160	.0015	0.30	3.9
18931	Mar. 31	Distinct.	Slight, earthy.	0.63	5.05	1.90	.0224	.0256	.0230	.0026	.37	.0270	.0003	0.57	1.4
19157	May 3	V. slight.	V. slight.	0.55	5.35	2.10	.0086	.0240	.0208	.0032	.34	.0250	.0005	0.55	1.7
19355	June 1	V. slight.	Slight.	0.52	5.20	2.10	.0116	.0216	.0186	.0030	.32	.0200	.0004	0.50	1.8
19699	July 1	V. slight.	Slight.	0.69	5.40	2.10	.0086	.0208	.0196	.0012	.39	.0120	.0007	0.66	1.7
19967	Aug. 2	V. slight.	V. slight.	0.50	6.05	2.25	.0018	.0240	.0220	.0020	.38	.0280	.0004	0.64	2.0
20345	Sept. 1	None.	None.	0.08	9.75	2.00	.0012	.0096	.0078	.0018	.53	.0550	.0002	0.16	3.8
20702	Oct. 4	Slight.	Slight.	0.60	6.00	2.00	.0030	.0264	.0242	.0022	.39	.0080	.0001	0.65	2.9
21023	Nov. 1	V. slight.	V. slight.	0.45	6.15	2.10	.0014	.0236	.0226	.0010	.44	.0050	.0002	0.54	2.3
21417	Dec. 1	Decided.	Slight.	0.17	12.65	2.25	.0030	.0106	.0104	.0002	.66	.1050	.0008	0.15	4.9

Averages by Years.

-	1888	-	-	1.16	6.25	2.17	.0039	.0312	-	-	.51	.0303	.0004	-	-
-	1889	-	-	1.11	5.04	1.76	.0061	.0308	.0280	.0028	.50	.0275	.0005	-	-
-	1890	-	-	0.72	7.31	2.12	.0033	.0257	.0225	.0032	.56	.0262	.0003	-	2.4
-	1891	-	-	0.86	6.15	2.24	.0047	.0291	.0256	.0035	.59	.0226	.0003	-	2.0
-	1892	-	-	0.96	6.19	2.35	.0015	.0291	.0252	.0039	.49	.0202	.0002	-	1.9
-	1893	-	-	0.95	6.03	2.27	.0027	.0273	.0237	.0036	.50	.0127	.0002	0.83	2.0
-	1894	-	-	1.32	6.41	2.64	.0023	.0302	.0249	.0053	.49	.0151	.0001	1.05	2.0
-	1895	-	-	1.03	6.55	2.30	.0041	.0310	.0266	.0044	.49	.0196	.0003	0.98	2.0
-	1896	-	-	0.94	7.47	2.50	.0060	.0317	.0253	.0064	.41	.0187	.0003	0.94	2.3
-	1897	-	-	0.50	7.43	2.15	.0103	.0227	.0205	.0022	.46	.0409	.0005	0.52	2.6

NOTE to analyses of 1897: Odor, generally distinctly vegetable. —— The samples were collected from the brook, about 50 feet below the first road above Reservoir No. 3, at a depth of 1 foot beneath the surface.

BOSTON.

SUDBURY RIVER SUPPLY.— *Chemical Examination of Water from Reservoir No. 3, Framingham.*

[Parts per 100,000.]

Number.	Date of Collection.	Appearance.			Residue on Evaporation.		Ammonia.				Chlorine.	Nitrogen as		Oxygen Consumed.	Hardness.
		Turbidity.	Sediment.	Color.	Total.	Loss on Ignition.	Free.	Albuminoid Total.	Albuminoid Dissolved.	Albuminoid Suspended.		Nitrates.	Nitrites.		
	1897.														
18235	Jan. 11	Slight.	Slight.	0.90	7.95	2.20	.0044	.0262	.0260	.0002	.52	.0280	.0003	.85	2.3
18414	Feb. 1	Distinct.	Slight.	1.10	7.15	2.15	.0066	.0226	.0214	.0012	.47	.0280	.0002	.78	2.2
18681	Mar. 1	Slight.	V. slight.	0.70	6.65	2.25	.0142	.0218	.0190	.0028	.49	.0380	.0005	.57	2.2
18932	Mar. 31	Distinct.	Slight.	0.55	4.80	1.65	.0008	.0180	.0146	.0034	.38	.0300	.0002	.55	1.4
19158	May 3	Slight.	Slight.	0.48	4.15	1.25	.0018	.0192	.0180	.0012	.32	.0200	.0002	.42	1.6
19356	June 1	Distinct.	Slight.	0.60	4.15	1.90	.0008	.0336	.0212	.0124	.30	.0130	.0002	.50	1.9
19700	July 1	Slight.	Slight.	0.43	4.30	1.60	.0026	.0220	.0172	.0048	.36	.0070	.0003	.53	1.6
19968	Aug. 2	Slight.	V. slight.	0.41	5.00	1.85	.0008	.0272	.0182	.0090	.34	.0100	.0004	.54	2.0
20346	Sept. 1	V. slight.	V. slight.	0.42	4.75	1.70	.0026	.0266	.0192	.0074	.37	.0070	.0000	.51	1.6
20703	Oct. 4	Slight.	Slight.	0.45	5.30	1.80	.0014	.0218	.0198	.0020	.38	.0030	.0000	.52	1.8
21024	Nov. 1	V. slight.	V. slight.	0.60	5.60	2.10	.0018	.0276	.0250	.0026	.42	.0030	.0002	.53	2.1
21418	Dec. 1	Decided.	Cons.	0.44	5.20	1.50	.0026	.0254	.0248	.0006	.41	.0060	.0001	.49	2.6

Averages by Years.

-	1888	-	-	0.98	4.98	1.79	.0038	.0288	-	-	.40	.0218	.0003	-	-
-	1889	-	-	0.84	4.39	1.50	.0042	.0306	.0254	.0052	.42	.0182	.0003	-	-
-	1890	-	-	0.62	5.40	1.84	.0020	.0238	.0197	.0041	.40	.0229	.0002	-	2.0
-	1891	-	-	0.60	4.75	1.66	.0032	.0242	.0200	.0042	.38	.0190	.0002	-	1.7
-	1892	-	-	0.72	5.17	1.97	.0024	.0254	.0219	.0035	.40	.0211	.0001	-	1.8
-	1893	-	-	0.90	4.97	2.10	.0028	.0259	.0207	.0052	.37	.0100	.0001	.77	1.7
-	1894	-	-	0.97	5.48	2.20	.0018	.0265	.0231	.0034	.41	.0105	.0002	.87	1.9
-	1895	-	-	0.86	5.43	2.22	.0027	.0273	.0231	.0042	.41	.0151	.0001	.84	1.8
-	1896	-	-	0.66	5.04	1.92	.0030	.0234	.0193	.0041	.37	.0144	.0001	.66	1.7
-	1897	-	-	0.59	5.42	1.83	.0034	.0243	.0203	.0040	.40	.0161	.0002	.57	1.9

NOTE to analyses of 1897: Odor, distinctly vegetable; in June, fishy and oily.—— The samples were collected from the reservoir, near the gate-house, at a depth of 8 feet beneath the surface. For monthly record of height of water in this reservoir, see table on page 135. The quality of the water of this source and of Stony Brook may have been affected during much of the year by work incident to the construction of Reservoir No. 5 on Stony Brook, above Reservoir No. 3.

BOSTON.

SUDBURY RIVER SUPPLY. — *Microscopical Examination of Water from Reservoir No. 3, Framingham.*

[Number of organisms per cubic centimeter.]

	1897.											
	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
Day of examination,	12	4	3	1	5	3	3	3	2	5	3	2
Number of sample,	18235	18414	18681	18932	19158	19356	19700	19968	20346	20703	21024	21418
PLANTS.												
Diatomaceæ,	286	17	8	6	428	459	1,858	392	50	288	374	266
Asterionella,	64	0	0	0	124	66	26	120	0	110	90	51
Cyclotella,	4	3	0	0	18	88	872	128	16	8	6	50
Melosira,	4	0	3	0	86	9	0	0	0	32	36	0
Synedra,	0	1	1	1	40	0	0	10	2	68	6	2
Tabellaria,	204	13	4	5	160	296	960	128	32	54	236	163
Cyanophyceæ,	0	0	0	0	0	141	2	22	50	94	18	4
Anabæna,	0	0	0	0	0	138	0	0	10	68	4	4
Clathrocystis,	0	0	0	0	0	2	0	10	6	8	4	0
Cœlosphærium,	0	0	0	0	0	1	2	10	18	14	6	0
Merismopœdia,	0	0	0	0	0	0	0	0	10	4	0	0
Algæ,	8	2	0	0	4	94	2	318	162	72	76	44
Botryococcus,	0	0	0	0	0	0	0	0	62	0	0	22
Protococcus,	0	2	0	0	4	88	0	140	94	40	22	12
Staurogenia,	0	0	0	0	0	0	0	136	0	10	4	0
ANIMALS.												
Rhizopoda, Actinophrys,	0	0	0	0	2	0	0	2	4	0	0	0
Infusoria,	0	1	3	23	15	245	0	0	10	18	36	85
Dinobryon,	0	0	0	20	8	44	0	0	0	0	30	82
Synura,	0	0	0	0	0	0	0	0	0	2	0	0
Uroglena,	0	0	0	0	3	188	0	0	0	0	0	0
Vermes,	1	0	0	0	0	1	0	0	4	4	0	3
Crustacea,	pr.	0	0	0	pr.	pr.	pr.	0	0	0	pr.	0
Miscellaneous, Zoöglœa,	20	40	40	35	0	40	20	10	25	20	5	20
TOTAL,	315	60	51	64	489	980	1,882	744	305	496	509	422

BOSTON.

COCHITUATE SUPPLY. — *Chemical Examination of Water from Lake Cochituate in Wayland.*

[Parts per 100,000.]

Number.	Date of Collection.	Appearance.			Residue on Evaporation.		Ammonia.				Chlorine.	Nitrogen as		Oxygen Consumed.	Hardness.
								Albuminoid.							
		Turbidity.	Sediment.	Color.	Total.	Loss on Ignition.	Free.	Total.	Dissolved.	Sus-pended.		Nitrates.	Nitrites.		
	1897.														
18236	Jan. 11	Slight.	Slight.	.25	6.80	1.85	.0006	.0216	.0170	.0046	.56	.0100	.0002	.39	2.3
18417	Feb. 1	V. slight.	Slight.	.40	5.50	1.55	.0004	.0178	.0164	.0014	.56	.0170	.0001	.45	1.9
18682	Mar. 1	Slight.	V. slight.	.40	5.50	1.65	.0008	.0212	.0196	.0016	.56	.0180	.0001	.49	2.1
18933	Mar. 31	Slight.	Slight.	.35	5.00	1.95	.0018	.0180	.0162	.0018	.52	.0180	.0001	.43	1.8
19159	May 3	V. slight.	V. slight.	.33	4.85	1.20	.0006	.0184	.0180	.0004	.50	.0150	.0002	.56	2.3
19357	June 1	Distinct.	Slight.	.30	4.75	1.65	.0008	.0252	.0170	.0082	.48	.0070	.0002	.50	2.1
19701	July 1	V. slight.	V. slight.	.30	4.65	1.85	.0016	.0202	.0178	.0024	.52	.0050	.0002	.44	1.8
19971	Aug. 2	V. slight.	V. slight	.18	4.70	1.75	.0004	.0194	.0158	.0036	.49	.0070	.0000	.45	2.0
20347	Sept. 1	V. slight.	V. slight.	.23	4.70	2.25	.0018	.0204	.0168	.0036	.49	.0020	.0000	.41	2.0
20705	Oct. 4	V. slight.	V. slight.	.32	5.05	1.70	.0004	.0192	.0154	.0038	.53	.0030	.0001	.44	2.0
21025	Nov. 1	V. slight.	V. slight.	.26	5.00	1.90	.0012	.0194	.0194	.0000	.50	.0020	.0002	.39	2.1
21422	Dec. 2	V. slight.	Slight.	.39	4.85	1.50	.0038	.0212	.0170	.0042	.50	.0070	.0000	.36	2.6

Averages by Years.

-	1888	-	-	.19	4.90	1.24	.0033	.0217	-	-	.43	.0127	.0003	-	-
-	1889	-	-	.33	5.08	1.62	.0025	.0210	.0177	.0033	.46	.0208	.0003	-	-
-	1890	-	-	.21	4.74	1.03	.0016	.0184	.0149	.0035	.49	.0206	.0003	-	2.4
-	1891	-	-	.24	4.66	1.44	.0017	.0182	.0145	.0037	.42	.0212	.0002	-	1.8
-	1892	-	-	.15	4.61	1.35	.0018	.0168	.0133	.0035	.48	.0152	.0001	-	2.0
-	1893	-	-	.21	4.64	1.58	.0015	.0168	.0138	.0030	.46	.0098	.0002	.39	2.0
-	1894	-	-	.20	4.76	1.59	.0008	.0163	.0137	.0026	.51	.0070	.0001	.37	2.1
-	1895	-	-	.25	5.08	1.68	.0015	.0178	.0153	.0025	.51	.0112	.0001	.42	2.1
-	1896	-	-	.28	4.89	1.65	.0012	.0176	.0145	.0031	.50	.0122	.0001	.45	1.9
-	1897	-	-	.31	5.11	1.73	.0012	.0202	.0172	.0030	.52	.0092	.0001	.44	2.1

NOTE to analyses of 1897: Odor, vegetable and sometimes mouldy, becoming stronger on heating. —— The samples were collected in the gate-house. For monthly record of height of water in this lake, see table on page 135.

BOSTON.

Cochituate Supply. — *Microscopical Examination of Water from Lake Cochituate in Wayland.*

[Number of organisms per cubic centimeter.]

	1897.											
	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
Day of examination,	12	4	3	1	5	3	3	3	2	5	3	3
Number of sample,	18236	18417	18682	18933	19159	19357	19701	19971	20347	20705	21025	21422
PLANTS.												
Diatomaceæ,	**676**	**628**	**132**	**288**	**156**	**888**	**268**	**39**	**152**	**208**	**278**	**2,080**
Asterionella,	152	276	32	100	26	58	0	0	30	24	168	240
Cyclotella,	48	44	0	0	12	204	64	8	6	2	16	32
Fragilaria,	0	0	0	0	0	0	0	0	28	94	34	28
Melosira,	476	204	70	130	78	0	0	7	0	0	24	324
Synedra,	0	48	4	4	24	118	0	16	46	40	2	8
Tabellaria,	0	56	26	54	16	508	204	8	42	48	34	1,448
Cyanophyceæ,	**36**	**132**	**12**	**6**	**0**	**14**	**68**	**24**	**46**	**42**	**26**	**112**
Anabæna,	0	0	0	0	0	10	0	21	28	28	2	4
Aphanizomenon,	0	0	0	0	0	3	0	0	0	10	18	104
Clathrocystis,	0	0	0	0	0	0	0	0	14	4	2	0
Microcystis,	0	0	0	0	0	0	68	0	0	0	2	4
Oscillaria,	36	132	12	6	0	1	0	0	0	0	0	0
Algæ,	**0**	**0**	**0**	**2**	**2**	**3**	**6**	**27**	**96**	**16**	**2**	**18**
Protococcus,	0	0	0	0	0	0	2	15	78	8	0	16
ANIMALS.												
Rhizopoda, Actinophrys,	**0**	**0**	**0**	**2**	**0**	**0**	**0**	**0**	**0**	**0**	**4**	**0**
Infusoria,	**26**	**96**	**25**	**21**	**0**	**0**	**0**	**3**	**2**	**2**	**5**	**8**
Mallomonas,	20	24	5	6	0	0	0	0	0	0	0	2
Synura,	0	0	8	4	0	0	0	0	0	0	0	0
Trachelomonas,	2	60	6	4	0	0	0	1	0	0	1	4
Crustacea,	**pr.**	**0**	**pr.**	**0**	**0**	**0**	**0**	**0**	**pr.**	**0**	**pr.**	**0**
Miscellaneous, Zoöglœa,	**20**	**40**	**40**	**30**	**35**	**0**	**10**	**5**	**20**	**5**	**3**	**20**
Total,	758	896	209	349	193	905	352	98	316	273	318	2,238

BOSTON.

COCHITUATE WORKS. — *Chemical Examination of Water from a Faucet at the State House, Boston.*

[Parts per 100,000.]

Number.	Date of Collection.	Appearance.			Residue on Evaporation.		Ammonia.				Chlorine.	Nitrogen as		Oxygen Consumed.	Hardness.
								Albuminoid.							
		Turbidity.	Sediment.	Color.	Total.	Loss on Ignition.	Free.	Total.	Dissolved.	Sus-pended.		Nitrates.	Nitrites.		
	1897.														
18418	Feb. 1	Slight.	Slight.	0.70	5.85	2.10	.0008	.0170	.0162	.0008	.46	.0230	.0002	.81	1.8
18683	Mar. 1	V. slight.	V. slight.	0.63	5.95	2.15	.0022	.0176	.0162	.0014	.44	.0200	.0001	.67	1.6
18934	Apr. 1	V. slight.	V. slight.	0.50	4.30	1.65	.0020	.0144	.0138	.0006	.38	.0200	.0001	.52	1.4
19160	May 4	V. slight.	Slight.	0.55	3.95	1.10	.0006	.0172	.0126	.0046	.36	.0100	.0000	.63	1.8
19379	June 3	V. slight.	Slight.	0.70	4.35	1.50	.0008	.0212	.0166	.0046	.33	.0130	.0000	.63	1.6
19702	July 1	V. slight.	Slight.	1.02	4.55	2.00	.0002	.0214	.0206	.0008	.35	.0120	.0000	.72	1.3
19972	Aug. 2	V. slight.	V. slight.	0.50	4.80	1.95	.0002	.0196	.0184	.0012	.37	.0150	.0000	.66	1.4
20348	Sept. 1	V. slight.	V. slight.	0.62	5.10	2.10	.0006	.0214	.0202	.0012	.38	.0130	.0000	.67	1.7
20704	Oct. 4	V. slight.	V. slight.	0.60	5.10	2.10	.0016	.0210	.0186	.0024	.38	.0080	.0001	.56	1.6
21026	Nov. 1	V. slight.	V. slight.	0.44	4.50	1.80	.0006	.0230	.0230	.0000	.40	.0060	.0001	.54	1.7
21402	Dec. 1	V. slight.	Slight.	0.85	4.60	1.80	.0004	.0180	.0180	.0000	.50	.0110	.0000	.63	1.8

*Averages by Years.**

-	1888	-	-	.38	4.94	1.53	.0012	.0215	-	-	.40	.0183	.0002	-	-
-	1889	-	-	.51	4.71	1.43	.0005	.0199	.0176	.0023	.42	.0272	.0002	-	-
-	1890	-	-	.35	4.70	1.25	.0003	.0169	.0148	.0021	.42	.0241	.0001	-	2.2
-	1891	-	-	.37	4.39	1.63	.0005	.0161	.0136	.0025	.37	.0227	.0001	-	1.7
-	1892	-	-	.37	4.70	1.67	.0007	.0168	.0138	.0030	.41	.0210	.0001	-	1.9
-	1893	-	-	.61	4.54	1.84	.0010	.0174	.0147	.0027	.38	.0143	.0001	.60	1.8
-	1894	-	-	.69	4.64	1.83	.0006	.0169	.0150	.0019	.41	.0106	.0001	.63	1.7
-	1895	-	-	.72	4.90	2.02	.0006	.0197	.0175	.0022	.40	.0171	.0001	.69	0.7
-	1896	-	-	.49	4.29	1.67	.0005	.0165	.0142	.0023	.37	.0155	.0001	.56	1.4
-	1897	-	-	.65	4.82	1.84	.0009	.0193	.0177	.0016	.40	.0137	.0001	.64	1.6

* Previous to 1897 these samples were collected from a faucet at the Institute of Technology. The character of the water at this place, however, does not differ materially from that of the water drawn from the tap at the State House.

NOTE to analyses of 1897: Odor, vegetable; of the last sample, none, becoming faintly musty on heating.

BOSTON.

COCHITUATE WORKS. — *Microscopical Examination of Water from a Faucet at the State House, Boston.*

[Number of organisms per cubic centimeter.]

	1897.										
	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
Day of examination,	4	3	1	6	5	3	3	2	5	3	2
Number of sample,	18418	18683	18934	19160	19379	19702	19972	20348	20704	21026	21402
PLANTS.											
Diatomaceæ,	144	86	31	304	382	227	33	100	258	256	237
Asterionella,	44	16	18	76	19	1	8	32	70	64	43
Cyclotella,	10	0	0	0	136	72	1	2	14	0	1
Fragilaria,	0	0	0	0	0	0	0	0	78	34	0
Melosira,	36	48	11	128	7	2	5	6	0	36	16
Tabellaria,	52	20	0	52	216	152	4	48	38	120	176
Cyanophyceæ, Anabæna,	0	0	0	0	0	0	2	4	10	0	0
Algæ,	0	0	0	1	5	1	26	2	4	4	3
ANIMALS.											
Rhizopoda, Actinophrys,	0	0	0	0	0	1	0	0	0	0	0
Infusoria,	10	3	2	8	0	0	12	0	2	26	1
Dinobryon,	2	0	2	5	0	0	12	0	0	24	0
Vermes, Anurea,	0	0	0	0	0	0	0	0	0	0	1
Miscellaneous, Zoöglœa,	20	20	20	15	35	40	8	25	15	0	5
TOTAL,	174	109	53	328	422	269	81	131	289	286	247

BOSTON.

MYSTIC SUPPLY. — *Chemical Examination of Water from Mystic Lake.*

[Parts per 100,000.]

Number.	Date of Collection.	Appearance. Turbidity.	Appearance. Sediment.	Appearance. Color.	Residue on Evaporation. Total.	Residue on Evaporation. Loss on Ignition.	Ammonia. Free.	Ammonia. Albuminoid. Total.	Ammonia. Albuminoid. Dissolved.	Ammonia. Albuminoid. Suspended.	Chlorine.	Nitrogen as Nitrates.	Nitrogen as Nitrites.	Oxygen Consumed.	Hardness.
	1897.														
18237	Jan. 11	Slight, milky.	Slight.	.15	10.30	1.45	.0118	.0148	.0144	.0004	1.38	.0680	.0005	.23	3.1
18396	Feb. 1	Slight.	V. slight.	.15	13.40	4.10	.0202	.0196	.0160	.0036	1.57	.1000	.0004	.34	4.2
18667	Mar. 1	Slight.	Slight.	.18	11.30	2.40	.0222	.0150	.0128	.0022	1.53	.0920	.0009	.30	4.6
18918	Mar. 31	Distinct.	Slight.	.30	9.95	2.55	.0192	.0216	.0172	.0044	1.26	.0750	.0005	.38	3.6
19143	May 3	Distinct, clayey.	Slight.	.23	10.95	2.55	.0006	.0306	.0156	.0150	1.37	.0700	.0007	.31	4.7
19502	June 18	Distinct.	Slight.	.32	10.60	2.40	.0012	.0310	.0186	.0124	1.10	.0400	.0008	.45	3.6
19689	July 1	Cons.	Slight.	.30	10.60	2.40	.0012	.0294	.0176	.0118	1.22	.0300	.0007	.45	3.6
19962	Aug. 2	Distinct.	V. slight.	.11	11.50	2.45	.0004	.0342	.0212	.0130	1.46	.0450	.0007	.37	4.2
20337	Sept. 1	V. slight.	V. slight.	.07	11.95	2.35	.0008	.0210	.0176	.0034	1.51	.0400	.0005	.25	4.4
20706	Oct. 4	V. slight.	V. slight.	.10	12.50	2.60	.0000	.0182	.0156	.0026	1.66	.0400	.0002	.25	4.2
21010	Nov. 1	None.	None.	.09	13.15	2.65	.0024	.0138	.0128	.0010	1.67	.0580	.0002	.30	4.9
21404	Dec. 1	V. slight.	Slight.	.12	12.80	2.25	.0436	.0218	.0172	.0046	1.57	.0630	.0005	.23	5.3

Averages by Years.

–	1888	–	–	.21	10.12	1.76	.0244	.0267	–	–	1.94	.0433	.0016	–	–
–	1889	–	–	.26	9.02	1.97	.0211	.0278	.0209	.0069	1.67	.0586	.0012	–	–
–	1890	–	–	.13	10.65	1.78	.0197	.0223	.0183	.0040	1.57	.0796	.0008	–	3.7
–	1891	–	–	.13	9.50	1.81	.0186	.0242	.0187	.0055	1.58	.0731	.0012	–	3.5
–	1892	–	–	.07	11.52	2.09	.0185	.0206	.0153	.0053	2.22	.0698	.0007	–	4.1
–	1893	–	–	.10	12.62	2.17	.0240	.0215	.0159	.0056	2.49	.0583	.0007	.27	4.4
–	1894	–	–	.11	15.60	2.56	.0381	.0235	.0168	.0067	3.48	.0583	.0012	.26	5.2
–	1895	–	–	.15	16.07	2.96	.0550	.0271	.0197	.0074	3.25	.0585	.0016	.32	5.4
–	1896	–	–	.15	11.71	2.46	.0156	.0220	.0134	.0086	1.68	.0569	.0008	.27	4.3
–	1897	–	–	.18	11.58	2.51	.0103	.0226	.0164	.0062	1.44	.0601	.0005	.32	4.2

NOTE to analyses of 1897: Odor, generally distinctly vegetable, frequently mouldy or musty, seldom unpleasant. —— The samples were collected from the lake, near the gate-house. For monthly record of height of water in this lake, see table on page 135.

BOSTON.

MYSTIC SUPPLY. — *Microscopical Examination of Water from Mystic Lake.*

[Number of organisms per cubic centimeter.]

	1897.											
	Jan.	Feb.	Mar	Mar.	May	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
Day of examination,	12	3	2	31	4	19	3	3	2	5	2	2
Number of sample,	18237	18396	18667	18918	19143	19502	19689	19962	20337	20706	21010	21404
PLANTS.												
Diatomaceæ,	1	6	36	68	48	3	2	5	5	22	30	152
Synedra,	0	3	0	16	24	2	2	5	5	20	26	128
Cyanophyceæ, Anabæna,	0	0	0	0	0	28	0	0	0	0	0	0
Algæ,	0	1	8	15	14	24	2	3	2	30	14	2
ANIMALS.												
Infusoria,	1	4	2	11	5	2	5	7	2	10	12	6
Ciliated infusorian,	0	0	0	0	0	0	0	0	0	10	12	2
Vermes,	0	0	0	0	0	0	0	1	3	0	0	2
Crustacea, Cyclops,	0	0	0	0	0	0	0	0	pr.	0	0	0
Miscellaneous, Zoöglœa,	10	60	50	60	10	180	220	15	40	10	5	60
TOTAL,	12	71	96	154	77	237	229	31	52	72	61	222

Table showing Monthly Heights in Feet above Tide-marsh Level of the Water in the Lakes and Storage Reservoirs of the Boston Water Works, from which Samples of Water were collected during the Year 1897.

1897.	Reservoir No. 2, Flash Boards, 167.12.	Reservoir No. 3, Stone Crest, 175.24.	Reservoir No. 4, Flash Boards, 215.21.	Reservoir No. 5, Stone Crest, 250 00.	Reservoir No. 6, Flash Boards, 295.00.	Farm Pond, High Water, 149.25.	Lake Cochituate, High Water, 134.36.	Mystic Lake, High Water, 7.00.
Jan. 1,	162.63	174.82	195.11	–	266.41	148.78	127.43	5.34
Feb. 1,	161.37	173.31	199.80	–	271.59	149.50	128.75	5.85
March 1,	162.50	174.44	204.19	218.16	276.04	149.21	129.26	6.14
April 1,	167.21	175.29	213.70	230.41	287.63	149.45	133.86	6.48
May 1,	167.66	176.45	215.38	232.22	292.31	149.40	134.27	6.67
June 1,	166.86	176.56	215.38	233.02	294.83	149.37	134.24	6.80
July 1,	162.90	176.76	215.34	233.21	295.09	149.32	133.92	6.83
Aug. 1,	167.77	176.50	209.04	233.17	294.23	149.14	133.16	5.74
Sept. 1,	163.54	172.82	210.23	233.31	294.89	149.11	132.61	5.04
Oct. 1,	162.89	169.12	205.65	231.96	294.77	148.39	131.09	1.87
Nov. 1,	162.70	169.70	200.97	226.16	291.65	148.33	129.43	−0.82
Dec. 1,	163.42	170.53	203.94	231.02	292.06	147.84	129.86	3.62

Boxford.

For analyses of water from Bald Pate Pond in Boxford, see Groveland.

Water Supply of Bradford.

This town was annexed to Haverhill Jan. 1, 1897. For analyses of samples of water, see Haverhill.

Water Supply of Braintree.

Chemical Examination of Water from the Filter-gallery of the Braintree Water Works.

[Parts per 100,000.]

Number.	Date of Collection.	Appearance.			Residue on Evaporation.	Ammonia.		Chlorine.	Nitrogen as		Oxygen Consumed.	Hardness.	Iron.
		Turbidity.	Sediment.	Color.		Free.	Albuminoid.		Nitrates.	Nitrites.			
	1897.												
18281	Jan. 19	None.	None.	.02	5.80	.0000	.0050	0.94	.0380	.0000	.05	1.7	.0030
18458	Feb. 9	None.	None.	.03	5.05	.0002	.0066	0.96	.0380	.0000	.07	2.2	.0015
18698	Mar. 3	None.	None.	.02	4.60	.0008	.0062	0.92	.0350	.0000	.10	1.8	.0090
18950	Apr. 5	None.	V. slight.	.02	5.60	.0004	.0036	0.92	.0400	.0000	.10	2.1	.0040
19225	May 12	None.	None.	.05	4.60	.0004	.0066	0.88	.0280	.0000	.15	1.6	.0000
19389	June 7	None.	None.	.10	4.10	.0004	.0066	0.80	.0130	.0000	.14	1.6	.0050
19743	July 8	None.	V. slight.	.05	4.60	.0018	.0050	0.87	.0380	.0000	.14	2.0	.0000
20018	Aug. 9	None.	None.	.03	5.80	.0022	.0030	0.82	.0150	.0000	.12	2.3	.0100
20394	Sept. 8	None.	None.	.05	5.50	.0002	.0074	0.83	.0120	.0008	.14	2.2	.0200
20728	Oct. 6	None.	None.	.05	5.50	.0016	.0054	0.83	.0130	.0000	.07	2.1	.0010
21064	Nov. 8	None.	V. slight.	.04	5.00	.0016	.0066	1.00	.0180	.0001	.07	2.1	.0070
21465	Dec. 7	None.	V. slight.	.04	6.20	.0022	.0072	0.96	.0570	.0000	.07	2.5	.0100

Averages by Years.

-	-*	-	-	.07	7.14	.0006	.0045	0.85	.0948	.0003	-	-	-
-	1892	-	-	.02	4.69	.0002	.0030	0.75	.0192	.0001	-	1.8	.0343
-	1893	-	-	.03	4.72	.0002	.0049	0.83	.0363	.0001	.10	1.8	.0037
-	1894	-	-	.04	5.19	.0004	.0048	0.86	.0338	.0001	.10	1.7	.0135
-	1895	-	-	.12	5.32	.0004	.0060	0.89	.0369	.0002	.13	2.0	.0417
-	1896	-	-	.08	5.55	.0006	.0051	0.86	.0329	.0000	.12	1.7	.0095
-	1897	-	-	.04	5.20	.0010	.0058	0.90	.0287	.0001	.10	2.0	.0059

* June, 1887, to May, 1888.

Note to analyses of 1897: Odor, none. —— The samples were collected from a faucet at the pumping station.

BRAINTREE.

Chemical Examination of Water from Little Pond, Braintree.

[Parts per 100,000.]

Number.	Date of Collection.	Appearance.			Residue on Evaporation.		Ammonia.				Chlorine.	Nitrogen as		Oxygen Consumed.	Hardness.
		Turbidity.	Sediment.	Color.	Total.	Loss on Ignition.	Free.	Albuminoid Total.	Albuminoid Dissolved.	Albuminoid Suspended.		Nitrates.	Nitrites.		
	1897.														
20017	Aug. 9	V. slight.	V. slight.	.19	4.30	1.70	.0006	.0226	.0192	.0034	.82	.0020	.0000	.53	0.8
20393	Sept. 8	V. slight.	V. slight.	.20	4.10	1.55	.0012	.0274	.0262	.0012	.80	.0000	.0000	.43	1.0

Odor, faintly vegetable, becoming stronger on heating; of the first sample, also mouldy.——The samples were collected from the pond.

Microscopical Examination.

In the first sample 116 organisms per cubic centimeter were found, 44 of which were *Anabæna*. In the last sample 53 organisms per cubic centimeter were found, 28 of which were *Anabæna*.

Water Supply of Bridgewater and East Bridgewater. — The Bridgewaters Water Company.

Chemical Examination of Water from the Wells of the Bridgewaters Water Company.

[Parts per 100,000.]

Number.	Date of Collection.	Appearance.			Residue on Evaporation.	Ammonia.		Chlorine.	Nitrogen as		Oxygen Consumed.	Hardness.	Iron.
		Turbidity.	Sediment.	Color.		Free.	Albuminoid.		Nitrates.	Nitrites.			
	1897.												
19901	July 26	Slight.	Slight.	.16	8.20	.0010	.0006	.41	.0040	.0000	.03	3.0	.0420

Odor, none.——The sample was collected from a faucet at the pumping station.

Microscopical Examination.

Fungi, *Crenothrix*, 3,800.

Water Supply of Brockton.

The advice of the State Board of Health to the city of Brockton, relative to securing an additional water supply from Silver Lake in the towns of Pembroke, Kingston and Plympton, and Pine Brook, Howard Brook and Monponsett Pond in the towns of Hanson and Halifax, may be found on pages 6 to 9 of this volume. For the results of analyses of water from these sources, see Halifax and Pembroke in this volume, and Kingston and Pembroke in the annual report for the year 1896.

BROCKTON.

Chemical Examination of Water from Salisbury Brook Storage Reservoir.

[Parts per 100,000.]

Number.	Date of Collection.	Appearance. Turbidity.	Appearance. Sediment.	Appearance. Color.	Residue on Evaporation. Total.	Residue on Evaporation. Loss on Ignition.	Ammonia. Free.	Ammonia. Albuminoid. Total.	Ammonia. Albuminoid. Dissolved.	Ammonia. Albuminoid. Suspended.	Chlorine.	Nitrogen as Nitrates.	Nitrogen as Nitrites.	Oxygen Consumed.	Hardness.
	1897.														
18290	Jan. 19	V. slight.	V. slight.	0.76	4.70	2.30	.0002	.0230	.0226	.0004	.51	.0030	.0001	0.82	0.9
18457	Feb. 8	V. slight.	V. slight.	0.90	4.30	1.90	.0032	.0198	.0174	.0024	.53	.0030	.0000	1.44	1.3
18711	Mar. 8	V. slight.	V. slight.	0.70	4.00	1.30	.0024	.0166	.0160	.0006	.50	.0030	.0000	0.64	0.8
18951	Apr. 5	V. slight.	Slight.	0.60	3.30	1.35	.0002	.0170	.0114	.0056	.42	.0000	.0000	0.52	0.3
19214	May 11	Slight.	Slight.	0.60	3.20	1.35	.0000	.0178	.0140	.0038	.43	.0000	.0000	0.59	0.6
19390	June 7	Slight.	V. slight.	0.90	3.20	1.40	.0004	.0228	.0172	.0056	.36	.0030	.0000	0.71	0.3
19732	July 7	Slight.	Slight.	1.03	3.30	1.75	.0000	.0280	.0210	.0070	.33	.0020	.0000	0.86	0.8
20042	Aug. 10	Slight.	Slight.	0.93	3.80	1.65	.0012	.0302	.0228	.0074	.41	.0020	.0000	0.80	0.7
20397	Sept. 7	Slight.	Cons.	0.90	4.15	1.95	.0002	.0322	.0250	.0072	.42	.0020	.0000	0.87	0.8
20729	Oct. 6	V. slight.	V. slight.	0.98	3.85	1.95	.0024	.0170	.0160	.0010	.40	.0000	.0000	0.73	0.8
21062	Nov. 8	V. slight.	Decided.	0.90	3.70	1.90	.0010	.0320	.0262	.0058	.48	.0030	.0001	0.70	1.0
21466	Dec. 7	Slight.	Cons.	0.99	4.05	1.80	.0020	.0274	.0246	.0028	.52	.0030	.0001	0.33	0.8
Av.	....	....	....	0.85	3.80	1.72	.0011	.0236	.0195	.0041	.44	.0020	.0000	0.75	0.8

Odor, vegetable and occasionally mouldy or unpleasant.——The samples were collected from the reservoir, near the gate-house, 1 foot beneath the surface. For monthly record of height of water in this reservoir, see page 139.

Microscopical Examination of Water from Salisbury Brook Storage Reservoir.

[Number of organisms per cubic centimeter.]

	1897. Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
Day of examination,	21	10	9	6	12	10	8	11	9	8	9	8
Number of sample,	18290	18457	18711	18951	19214	19390	19732	20042	20397	20729	21062	21466
PLANTS.												
Diatomaceæ,	**9**	**48**	**22**	**100**	**334**	**480**	**3,150**	**2,538**	**2,711**	**1,294**	**58**	**128**
Asterionella,	7	38	16	50	124	224	1,644	8	2,700	6	10	116
Cyclotella,	0	0	0	0	2	4	2	448	7	0	3	2
Melosira,	0	0	0	0	60	30	0	0	0	0	0	8
Synedra,	2	10	6	6	52	2	0	6	4	40	10	0
Tabellaria,	0	0	0	44	96	220	1,504	2,076	0	1,248	35	2
Algæ,	**0**	**2**	**0**	**0**	**7**	**10**	**3**	**22**	**9**	**156**	**2**	**6**
Raphidium,	0	0	0	0	0	0	0	0	0	108	2	6

BROCKTON.

Microscopical Examination of Water from Salisbury Brook Storage Reservoir — Concluded.

[Number of organisms per cubic centimeter.]

	1897.											
	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
ANIMALS.												
Infusoria,	60	24	354	162	19	3	161	16	20	8	19	8
Dinobryon,	0	10	304	72	0	0	0	0	20	0	0	0
Peridinium,	60	12	48	86	16	0	156	4	0	0	18	2
Uroglena,	0	0	0	4	0	0	0	0	0	0	0	0
Vermes,	1	0	0	4	1	2	1	2	0	2	3	4
Crustacea,	0	0	0	0	0	0	pr.	0	pr.	0	0	0
Miscellaneous, Zoöglœa,	15	60	0	10	5	70	20	40	3	25	15	5
TOTAL,	85	134	376	276	366	565	3,335	2,618	2,743	1,485	97	151

Chemical Examination of Water from Underdrains beneath the Sewers at Brockton.

[Parts per 100,000.]

Number.	Date of Collection.	Appearance.			Residue on Evaporation.	Ammonia.		Chlorine.	Nitrogen as		Oxygen Consumed.	Hardness.	Iron.
		Turbidity.	Sediment.	Color.		Free.	Albuminoid.		Nitrates.	Nitrites.			
	1897.												
19435	June 9	Slight.	Cons., brown.	.35	14.60	.4800	.0200	1.90	.2350	.0070	.34	5.9	.0800
20781	Oct. 13	Slight.	Slight.	.50	14.90	.2000	.0188	2.16	.0900	.0104	.23	5.1	.1100

Odor, distinctly tarry and disagreeable. —— The samples were collected from an underdrain, at its outlet into Salisbury Plain River, at Factory Village.

Table showing Height of Water in Salisbury Brook Storage Reservoir, Brockton, on the First Day of Each Month in 1897.

[NOTE. — High-water mark is 14.25 feet.]

Date.	Height of Water.	Date.	Height of Water.
1897.	Feet.	1897.	Feet.
Jan. 1,	14.33	July 1,	15.22
Feb. 1,	14.33	Aug. 1,	14.88
March 1,	14.39	Sept. 1,	14.25
April 1,*	14.68	Oct. 1,	13.11
May 1,	15.45	Nov. 1,	11.88
June 1,	15.75	Dec. 1,	14.35

* About April 1, 1897, the water was raised temporarily 18 inches above high-water mark.

BROOKLINE.

Water Supply of Brookline.

Chemical Examination of Water from a Faucet at the Low-service Pumping Station of the Brookline Water Works.

[Parts per 100,000.]

Number.	Date of Collection.	Appearance.			Residue on Evaporation.	Ammonia.		Chlorine.	Nitrogen as		Oxygen Consumed.	Hardness.	Iron.
		Turbidity.	Sediment.	Color.		Free.	Albu-minoid.		Nitrates.	Nitrites.			
	1897.												
18510	Feb. 15	None.	None.	.00	8.60	.0016	.0032	.63	.0480	.0000	.05	4.2	.0000
19014	Apr. 12	None.	None.	.05	9.70	.0012	.0040	.54	.0250	.0000	.10	4.4	.0000
19463	June 14	None.	None.	.02	8.30	.0008	.0042	.51	.0500	.0000	.14	4.4	.0000
20116	Aug. 16	None.	None.	.03	8.70	.0014	.0040	.53	.0250	.0000	.16	4.7	.0040
20771	Oct. 12	None.	None.	.02	9.50	.0020	.0038	.55	.0350	.0001	.10	4.7	.0010
21521	Dec. 13	None.	None.	.05	9.30	.0022	.0056	.60	.0320	.0000	.06	5.1	.0020
Av...	....	....	....	.03	9.02	.0015	.0041	.56	.0358	.0000	.10	4.6	.0012

Odor, none. —— The samples were collected from a faucet at the low-service pumping station, located near the Charles River, in the West Roxbury district of the city of Boston, and represent a mixture of water from the filter-gallery and tubular wells.

Chemical Examination of Water from the Covered Reservoir of the Brookline Water Works.

[Parts per 100,000.]

Number.	Date of Collection.	Appearance.			Residue on Evaporation.	Ammonia.		Chlorine.	Nitrogen as		Oxygen Consumed.	Hardness.	Iron.
		Turbidity.	Sediment.	Color.		Free.	Albu-minoid.		Nitrates.	Nitrites.			
	1897.												
18511	Feb. 16	None.	None.	.00	8.70	.0004	.0030	.64	.0400	.0000	.06	4.7	.0000
19015	Apr. 13	None.	None.	.05	9.60	.0004	.0038	.56	.0250	.0000	.10	4.4	.0000
19464	June 15	None.	None.	.02	9.00	.0004	.0040	.51	.0450	.0000	.12	4.6	.0000
20117	Aug. 17	None.	None.	.03	8.60	.0014	.0040	.53	.0250	.0000	.16	4.7	.0000
20772	Oct. 13	None.	None.	.00	9.00	.0016	.0044	.56	.0270	.0000	.11	4.7	.0010
21518	Dec. 14	V. slight.	None.	.05	8.00	.0004	.0052	.61	.0400	.0000	.06	5.4	.0070
Av...	....	....	....	.02	8.82	.0008	.0041	.57	.0337	.0000	.10	4.7	.0013

Odor, none. —— The samples were collected from the reservoir.

BROOKLINE.

Chemical Examination of Water from Charles River, opposite the Filter-gallery of the Brookline Water Works at West Roxbury.

[Parts per 100,000.]

Number.	Date of Collection.	Appearance.			Residue on Evaporation.		Ammonia.				Chlorine.	Nitrogen as		Oxygen Consumed.	Hardness.
		Turbidity.	Sediment.	Color.	Total.	Loss on Ignition.	Free.	Albuminoid. Total.	Albuminoid. Dissolved.	Albuminoid. Sus-pended.		Nitrates.	Nitrites.		
	1897.														
19462	June 14	V. slight.	V. slight.	1.08	4.75	2.50	.0012	.0280	.0244	.0036	.18	.0150	.0001	1.04	1.3
19842	July 20	V. slight.	V. slight.	1.00	5.05	1.90	.0012	.0322	.0270	.0052	.40	.0020	.0003	0.73	1.7
20115	Aug. 16	None.	V. slight.	1.20	5.90	2.85	.0012	.0344	.0330	.0014	.44	.0030	.0001	0.82	1.6
20487	Sept. 14	V. slight.	V. slight.	1.00	5.65	2.70	.0004	.0262	.0246	.0016	.47	.0000	.0001	0.93	1.6
20770	Oct. 12	V. slight.	V. slight.	0.65	4.80	1.90	.0004	.0220	.0202	.0018	.53	.0080	.0001	0.57	1.4
21242	Nov. 15	V. slight.	V. slight.	1.20	6.00	2.85	.0026	.0300	.0278	.0022	.58	.0120	.0000	1.06	1.7
21520	Dec. 13	Distinct.	Slight.	1.00	5.75	2.65	.0012	.0252	.0216	.0036	.48	.0150	.0000	0.74	2.1
Av..	....	....	....	1.02	5.41	2.48	.0012	.0283	.0255	.0028	.44	.0079	.0001	0.84	1.6

Odor, generally distinctly vegetable, becoming sometimes mouldy or grassy on heating.

Water Supply of Cambridge.

The capacity of the sources of water supply of the city of Cambridge was increased during the year 1897 by the completion of two new storage reservoirs. These reservoirs were formed by dams constructed across Hobbs Brook in Waltham, one of the tributaries of Stony Brook, which enters that brook a short distance above the Stony Brook storage reservoir.

The lower reservoir has an area of 466.8 acres at high water. Its maximum depth is 26 feet, and its total storage capacity is about 2,450,000,000 gallons. Its average depth is about 16 feet.

The upper reservoir has an area of 91.6 acres at high water, a maximum depth of 15 feet, and its total storage capacity is about 242,000,000 gallons.

The bottoms of both of the reservoirs were prepared for the storage of water by removing the soil, muck and vegetable matter from the areas to be flowed. Much of the soil was deposited in shallow places around the sides of the reservoir, and these places were faced with gravel and the shores in many places are riprapped.

CAMBRIDGE.

The area of the watershed above the dam of the lower reservoir is 6.6 square miles, including the areas of water surfaces. It contains considerable population, mostly in scattered farm-houses. From the lower reservoir the water flows 3.8 miles in the channel of the brook to the Stony Brook Reservoir. The watershed tributary to the brook in this vicinity, as well as the watershed of Stony Brook, contains a considerable population, but no large villages. From the Stony Brook Reservoir the water flows to Fresh Pond through a conduit a little less than 8 miles in length.

A new distributing reservoir, known as Payson Park Reservoir, situated in Belmont, was completed in 1897. The reservoir has a total area of about 7.4 acres at high water, and its general depth is from 20 to 21 feet. Its capacity is 43,000,000 gallons.

Chemical Examination of Water from Fresh Pond, Cambridge.

[Parts per 100,000.]

Number.	Date of Collection.	Appearance.			Residue on Evaporation.		Ammonia.				Chlorine.	Nitrogen as		Oxygen Consumed.	Hardness.
		Turbidity.	Sediment.	Color.	Total.	Loss on Ignition.	Free.	Albuminoid. Total.	Albuminoid. Dissolved.	Albuminoid. Sus-pended.		Nitrates.	Nitrites.		
	1897.														
18239	Jan. 12	Slight.	Slight.	.33	8.65	2.30	.0042	.0198	.0190	.0008	.72	.0280	.0011	.42	3.8
18426	Feb. 3	Slight.	Slight.	.38	7.70	2.45	.0016	.0166	.0134	.0032	.76	.0270	.0002	.45	3.5
18684	Mar. 2	V. slight.	V. slight.	.40	8.40	2.35	.0028	.0192	.0186	.0006	.74	.0380	.0004	.50	3.5
18949	April 5	V. slight.	V. slight.	.43	7.70	2.50	.0004	.0200	.0150	.0050	.74	.0400	.0006	.45	3.6
19162	May 4	V. slight.	Slight.	.30	6.85	1.45	.0036	.0208	.0166	.0042	.64	.0450	.0005	.39	3.4
19369	June 2	Slight.	Cons.	.33	7.35	2.55	.0030	.0264	.0182	.0082	.63	.0370	.0003	.43	3.4
19723	July 6	V. slight.	Slight.	.35	6.85	2.15	.0048	.0170	.0158	.0012	.62	.0250	.0005	.40	3.0
19981	Aug. 3	Slight.	Slight.	.28	6.65	2.00	.0018	.0248	.0186	.0062	.61	.0250	.0009	.45	3.1
20376	Sept. 6	Slight.	Slight.	.35	6.85	2.00	.0008	.0232	.0172	.0060	.58	.0080	.0005	.46	2.9
20713	Oct. 4	Slight	Slight.	.33	6.90	2.35	.0006	.0228	.0190	.0038	.60	.0120	.0001	.33	3.5
21030	Nov. 2	V. slight.	V. slight.	.40	7.10	2.00	.0172	.0242	.0190	.0052	.60	.0080	.0006	.38	3.8
21445	Dec. 6	V. slight.	Cons.	.40	7.45	2.35	.0140	.0292	.0206	.0086	.68	.0250	.0018	.42	4.0

Averages by Years.

–	1888	–	–	.17	11.14	1.79	.0132	.0206	–	–	1.10	.0261	.0007	–	–
–	1889	–	–	.11	9.86	1.83	.0145	.0220	.0170	.0050	0.90	.0334	.0008	–	–
–	1890	–	–	.11	8.90	1.34	.0098	.0221	.0168	.0053	0.83	.0303	.0004	–	4.1
–	1891	–	–	.15	7.94	1.80	.0095	.0235	.0162	.0073	0.75	.0333	.0004	–	3.8
–	1892	–	–	.16	7.23	1.57	.0086	.0210	.0161	.0049	0.67	.0249	.0003	–	3.4
–	1893	–	–	.27	6.66	1.82	.0106	.0202	.0165	.0037	0.58	.0285	.0006	.40	3.2
–	1894	–	–	.30	6.98	1.81	.0063	.0199	.0162	.0037	0.66	.0183	.0007	.41	3.1
–	1895	–	–	.35	7.43	2.15	.0054	.0245	.0189	.0055	0.69	.0221	.0004	.47	3.3
–	1896	–	–	.29	7.68	2.10	.0020	.0220	.0175	.0045	0.72	.0372	.0006	.42	3.4
–	1897	–	–	.36	7.87	2.20	.0046	.0220	.0176	.0044	0.66	.0265	.0006	.42	3.5

NOTE to analyses of 1897: Odor, generally distinctly vegetable. —— The samples were collected from the pump well at the pumping station. For monthly record of height of water in this pond, see page 146.

CAMBRIDGE.

Microscopical Examination of Water from Fresh Pond, Cambridge.

[Number of organisms per cubic centimeter.]

	1897.											
	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
Day of examination,	13	5	3	6	6	4	8	4	7	7	3	6
Number of sample,	18239	18426	18684	18949	19162	19369	19723	19981	20376	20713	21030	21445
PLANTS.												
Diatomaceæ,	**237**	**484**	**28**	**632**	**620**	**1,118**	**517**	**28**	**64**	**303**	**622**	**2,094**
Asterionella,	22	44	0	76	58	24	4	0	0	16	156	1,044
Cyclotella,	0	104	2	28	0	484	76	4	4	4	24	62
Fragilaria,	0	0	0	0	0	0	0	0	60	246	6	80
Melosira,	11	0	20	504	476	35	13	12	0	0	248	700
Tabellaria,	162	332	0	0	28	572	424	4	0	36	188	208
Cyanophyceæ,	**0**	**0**	**0**	**0**	**0**	**26**	**100**	**60**	**74**	**30**	**22**	**44**
Anabæna,	0	0	0	0	0	5	0	42	56	14	8	20
Aphanizomenon,	0	0	0	0	0	20	90	0	0	0	0	20
Cœlosphærium,	0	0	0	0	0	1	0	14	14	14	12	4
Microcystis,	0	0	0	0	0	0	10	4	4	2	2	0
Algæ,	**2**	**8**	**34**	**3**	**14**	**150**	**24**	**150**	**1,410**	**526**	**96**	**68**
Staurastrum,	1	4	4	2	6	84	12	140	1,408	512	68	40
ANIMALS.												
Infusoria,	**3**	**16**	**16**	**23**	**2**	**13**	**2**	**3**	**8**	**6**	**34**	**6**
Trachelomonas,	3	16	8	20	0	0	1	3	0	4	32	4
Zoöthamnium,	0	0	0	0	0	12	0	0	0	0	0	0
Vermes,	**0**	**0**	**0**	**0**	**2**	**0**	**0**	**1**	**2**	**2**	**0**	**0**
Crustacea,	**0**	**0**	**0**	**0**	**pr.**	**pr.**	**0**	**pr.**	**0**	**0**	**0**	**pr.**
Miscellaneous, Zoögloea,	10	20	20	60	10	25	10	5	3	20	3	10
TOTAL,	252	528	98	718	648	1,332	653	247	1,561	887	777	2,222

CAMBRIDGE.

Chemical Examination of Water from Stony Brook Storage Reservoir, Waltham.

[Parts per 100,000.]

Number.	Date of Collection.	Appearance. Turbidity.	Appearance. Sediment.	Appearance. Color.	Residue on Evaporation. Total.	Residue on Evaporation. Loss on Ignition.	Ammonia. Free.	Ammonia. Albuminoid. Total.	Ammonia. Albuminoid. Dissolved.	Ammonia. Albuminoid. Suspended.	Chlorine.	Nitrogen as Nitrates.	Nitrogen as Nitrites.	Oxygen Consumed.	Hardness.
	1897.														
18241	Jan. 12	Distinct.	Slight.	0.85	7.70	2.90	.0066	.0278	.0264	.0014	.57	.0400	.0001	.82	2.2
18420	Feb. 2	Slight.	V. slight.	0.60	5.95	1.90	.0000	.0218	.0202	.0016	.47	.0300	.0001	.52	2.1
18691	Mar. 2	Slight.	Slight.	0.50	5.45	1.80	.0040	.0186	.0172	.0014	.44	.0280	.0001	.58	1.7
18968	April 6	Slight.	Slight.	0.65	4.85	1.90	.0032	.0278	.0220	.0058	.43	.0250	.0002	.63	1.7
19163	May 4	V. slight.	V. slight.	0.70	4.90	1.65	.0012	.0240	.0232	.0008	.44	.0500	.0001	.62	2.1
19377	June 2	Slight.	Slight.	1.00	6.00	2.30	.0022	.0288	.0238	.0050	.40	.0180	.0001	.70	2.9
19720	July 6	Distinct.	Slight.	1.00	7.25	2.95	.0034	.0326	.0264	.0062	.42	.0050	.0001	.72	2.3
19987	Aug. 3	Slight.	Slight.	0.52	6.35	2.20	.0014	.0322	.0238	.0084	.48	.0170	.0003	.63	2.6
20417	Sept. 9	V. slight.	V. slight.	0.68	7.10	2.70	.0006	.0302	.0266	.0036	.44	.0050	.0003	.80	2.5
20712	Oct. 5	Slight.	Slight.	0.65	6.90	2.65	.0012	.0294	.0230	.0064	.46	.0050	.0002	.65	2.9
21035	Nov. 2	V. slight.	Slight.	0.45	6.75	2.45	.0040	.0266	.0252	.0014	.52	.0080	.0002	.52	2.9
21462	Dec. 7	V. slight.	Slight.	0.70	7.65	2.45	.0040	.0278	.0258	.0020	.52	.0140	.0001	.74	3.4

Averages by Years.

-	1888	-	-	0.78	5.15	1.93	.0031	.0285	-	-	.34	.0169	.0002	-	-
-	1889	-	-	0.87	4.59	1.47	.0032	.0280	.0249	.0031	.38	.0162	.0003	-	-
-	1890	-	-	0.61	5.86	2.02	.0016	.0222	.0182	.0040	.37	.0208	.0002	-	2.3
-	1891	-	-	0.56	4.99	1.86	.0016	.0213	.0183	.0030	.34	.0163	.0001	-	1.9
-	1892	-	-	0.72	5.43	1.79	.0015	.0241	.0202	.0039	.37	.0208	.0001	-	2.2
-	1893	-	-	0.66	5.32	1.97	.0020	.0235	.0196	.0039	.44	.0208	.0001	.60	2.1
-	1894	-	-	0.73	5.61	2.03	.0018	.0211	.0189	.0022	.46	.0174	.0001	.64	2.1
-	1895	-	-	0.84	5.90	2.41	.0015	.0280	.0235	.0045	.49	.0253	.0001	.79	2.2
-	1896	-	-	0.61	5.98	2.08	.0026	.0250	.0219	.0031	.49	.0219	.0001	.65	2.2
-	1897	-	-	0.69	6.40	2.32	.0026	.0273	.0236	.0037	.47	.0204	.0002	.66	2.4

NOTE to analyses of 1897: Odor, distinctly vegetable.——The samples were collected from the reservoir, near the surface, at the dam. For monthly record of height of water in this reservoir, see page 146.

CAMBRIDGE.

Microscopical Examination of Water from Stony Brook Storage Reservoir, Waltham.

[Number of organisms per cubic centimeter.]

	1897.											
	Jan.	Feb.	Mar.	Apr.	May.	June.	July	Aug.	Sept.	Oct	Nov.	Dec.
Day of examination,	13	4	5	7	6	4	7	4	9	7	3	8
Number of sample,	18241	18420	18691	18968	19163	19377	19720	19987	20417	20712	21035	21462
PLANTS.												
Diatomaceæ,	**5**	**0**	**1**	**26**	**304**	**94**	**1,362**	**2,148**	**1,468**	**910**	**160**	**188**
Asterionella,	0	0	0	2	0	60	192	42	1,460	160	8	10
Cyclotella,	1	0	0	2	0	2	208	48	0	2	52	132
Synedra.	4	0	0	12	288	24	110	34	8	18	10	18
Tabellaria,	0	0	0	10	16	8	852	2,008	0	704	88	28
Cyanophyceæ,	**0**	**0**	**0**	**0**	**0**	**0**	**4**	**18**	**0**	**58**	**0**	**0**
Anabæna,	0	0	0	0	0	0	4	12	0	52	0	0
Algæ,	**1**	**1**	**0**	**2**	**1**	**10**	**62**	**30**	**10**	**48**	**10**	**2**
ANIMALS.												
Infusoria,	**17**	**3**	**3**	**50**	**48**	**15**	**0**	**0**	**24**	**274**	**4**	**8**
Dinobryon,	15	0	1	50	30	6	0	0	24	250	0	0
Peridinium,	0	3	1	0	12	0	0	0	0	0	2	4
Trachelomonas,	0	0	1	0	0	0	0	0	0	16	2	0
Vermes,	**0**	**1**	**0**	**0**	**1**	**0**	**0**	**0**	**0**	**2**	**0**	**0**
Miscellaneous, Zoöglœa,	**10**	**5**	**0**	**20**	**120**	**35**	**70**	**8**	**0**	**25**	**3**	**5**
TOTAL,	33	10	4	100	474	154	1,498	2,204	1,502	1,319	177	203

Chemical Examination of Water from Hobbs Brook, at Winter Street, Waltham.

[Parts per 100,000.]

Number.	Date of Collection.	Appearance.			Residue on Evaporation.		Ammonia.				Chlorine.	Nitrogen as		Oxygen Consumed.	Hardness.
								Albuminoid.							
		Turbidity.	Sediment.	Color.	Total.	Loss on Ignition.	Free.	Total.	Dissolved.	Suspended.		Nitrates.	Nitrites.		
	1897.														
18353	Jan. 25	V. slight.	V. slight.	1.10	7.40	3.35	.0060	.0328	.0310	.0018	.40	.0100	.0001	1.01	2.1
18438	Feb 6	V. slight.	V. slight.	1.20	6.50	2.80	.0030	.0288	.0276	.0012	.40	.0160	.0001	0.86	2.2
19032	Apr. 13	Slight.	Slight.	0.80	5.55	2.35	.0030	.0340	.0312	.0028	.38	.0180	.0002	0.75	1.4
19189	May 7	Slight.	V. slight	1.00	5.00	2.55	.0044	.0390	.0368	.0022	.38	.0150	.0003	0.93	2.2
19380	June 2	Slight.	V slight.	1.10	5.55	2.25	.0060	.0346	.0310	.0036	.31	.0130	.0001	1.01	1.8
20000	Aug. 4	Slight.	V. slight	1.06	6.05	2.70	.0014	.0366	.0340	.0026	.36	.0080	.0002	1.02	2.2
20452	Sept. 10	V. slight	Cons.	0.68	7.10	2.55	.0054	.0370	.0250	.0120	.48	.0050	.0002	0.76	2.9
20722	Oct. 5	V. slight.	Slight.	0.45	6.75	2.50	.0008	.0344	.0310	.0034	.56	.0030	.0000	0.58	3.3
21039	Nov. 3	Slight.	Slight.	0.38	6.40	2.15	.0014	.0272	.0228	.0044	.56	.0020	.0000	0.47	2.9
21587	Dec. 16	V. slight	Slight.	0.94	6.55	2.55	.0006	.0354	.0320	.0034	.53	.0170	.0001	0.84	2.3
Av..	....	....	....	0.87	6.28	2.57	.0032	.0340	.0302	.0038	.44	.0107	.0001	0.82	2.3

Odor, distinctly vegetable and sometimes mouldy; in November, earthy. —— The samples were collected from the brook. The quality of the water of this source and of Stony Brook Reservoir may have been affected during a portion of the year by work incident to the construction of a storage reservoir upon Hobbs Brook, above the point where the samples were collected.

CAMBRIDGE.

Table showing Heights of Water in Fresh Pond and Stony Brook Storage Reservoir on the First Day of Each Month in 1897.

[Heights are in feet above Cambridge city base.]

Date.	Fresh Pond. High Water, 16.85.	Stony Brook Reservoir. Height of Rollway, 81.00	Date.	Fresh Pond. High Water, 16.85.	Stony Brook Reservoir. Height of Rollway, 81 00.
1897.			**1897.**		
Jan. 1,	12.35	81.11	July 1,	16.72	81.25
Feb. 1,	12.88	81.04	Aug. 1,	16.40	81.27
Mar. 1,	14.05	81.10	Sept. 1,	16.28	81.02
April 1,	15.52	81.50	Oct. 1,	15.76	77.00
May 1,	16.37	81.22	Nov. 1,	14.73	71.08
June 1,	17.03	81.17	Dec. 1,	15.37	81.15

Water Supply of Canton.

Chemical Examination of Water from the Springdale Well of the Canton Water Works.

[Parts per 100,000.]

Number.	Date of Collection.	Appearance.			Residue on Evaporation.	Ammonia.		Chlorine.	Nitrogen as		Oxygen Consumed.	Hardness.	Iron.
		Turbidity.	Sediment.	Color.		Free.	Albuminoid.		Nitrates.	Nitrites.			
20089	1897. Aug. 12	V. slight.	None.	.00	3.60	.0008	.0020	.35	.0080	.0000	.02	1.1	.0060

Odor, none. —— The sample was collected from the well.

Water Supply of Chelsea.

(See *Boston, Mystic Works.*)

Water Supply of Cheshire. — Cheshire Water Company.

Chemical Examination of Water from the Reservoir of the Cheshire Water Company.

[Parts per 100,000.]

Number.	Date of Collection.	Appearance.			Residue on Evaporation.	Ammonia.		Chlorine.	Nitrogen as		Oxygen Consumed.	Hardness.	Iron.
		Turbidity.	Sediment.	Color.		Free.	Albuminoid		Nitrates.	Nitrites.			
	1897.												
18622	Feb. 23	None.	V. slight.	.02	4.15	.0006	.0030	.08	.0170	.0000	.03	2.8	.0000
19136	Apr. 28	None.	None.	.00	2.90	.0000	.0024	.07	.0050	.0000	.07	2.2	.0000
19569	June 23	None.	V. slight.	.00	4.00	.0012	.0024	.06	.0100	.0000	.02	2.6	.0000
20294	Aug. 26	None.	None.	.02	5.50	.0004	.0020	.06	.0100	.0000	.11	3.8	.0010
20971	Oct. 26	V. slight.	V. slight.	.07	6.50	.0044	.0022	.10	.0170	.0000	.05	5.1	-
20717	Dec. 30	V. slight.	V. slight.	.02	4.00	.0004	.0020	.09	.0240	.0000	.03	3.0	.0020
Av...	....	....	....	.02	4.51	.0012	.0023	.08	.0138	.0000	.05	3.2	.0006

Odor of the first sample, faintly vegetable and mouldy; of the others, none. —— The samples were collected from a faucet in the village.

Water Supply of Chester.

Chemical Examination of Water from the Austin Brook Reservoir of the Chester Water Works.

[Parts per 100,000.]

Number.	Date of Collection.	Appearance.			Residue on Evaporation.		Ammonia.				Chlorine.	Nitrogen as		Oxygen Consumed.	Hardness.
								Albuminoid.							
		Turbidity.	Sediment.	Color.	Total.	Loss on ignition	Free.	Total.	Dissolved.	Suspended.		Nitrates.	Nitrites.		
	1897.														
20268	Aug. 24	None.	None.	.07	3.25	1.20	.0006	.0062	.0046	.0016	.09	.0050	.0000	.18	1.3

Odor, faintly unpleasant. —— The sample was collected from a faucet in the village.

CHICOPEE.

Water Supply of Chicopee.

Chemical Examination of Water from Cooley Brook Reservoir, Chicopee.

[Parts per 100,000.]

Number.	Date of Collection.	Appearance.			Residue on Evaporation.		Ammonia.				Chlorine.	Nitrogen as		Oxygen Consumed.	Hardness.
		Turbidity.	Sediment.	Color.	Total.	Loss on Ignition.	Free.	Albuminoid. Total.	Albuminoid. Dissolved.	Albuminoid. Suspended.		Nitrates.	Nitrites.		
	1897.														
18652	Feb. 25	Distinct.	Cons., earthy.	0.75	4.75	1.80	.0020	.0168	.0122	.0046	.10	.0050	.0000	0.67	1.1
19331	May 26	V. slight.	Slight.	1.50	4.60	2.10	.0010	.0218	.0170	.0048	.07	.0050	.0000	1.12	1.1
20114	Aug. 16	V. slight.	Slight.	2.30	6.35	3.55	.0012	.0390	.0282	.0108	.14	.0030	.0001	2.21	1.4
21373	Nov. 23	V. slight.	Heavy.	1.00	4.20	1.40	.0012	.0142	.0120	.0022	.12	.0030	.0000	0.66	1.3
Av..	....	....	....	1.39	4.97	2.21	.0013	.0229	.0173	.0056	.11	.0040	.0000	1.16	1.2

Odor of the first sample, distinctly mouldy, becoming distinctly vegetable on heating; of the others, vegetable.—— The samples were collected from the reservoir. The high color of the water appears to be due to the flooding of swamps on the watershed at times of high flow in the brook.

Chemical Examination of Water from Morton Brook Reservoir, Chicopee.

[Parts per 100,000.]

Number.	Date of Collection.	Appearance.			Residue on Evaporation.		Ammonia.				Chlorine.	Nitrogen as		Oxygen Consumed.	Hardness.
		Turbidity.	Sediment.	Color.	Total.	Loss on Ignition.	Free.	Albuminoid. Total.	Albuminoid. Dissolved.	Albuminoid. Suspended.		Nitrates.	Nitrites.		
	1897.														
18653	Feb. 25	V. slight.	V. slight.	.02	3.75	.95	.0000	.0040	.0028	.0012	.11	.0100	.0000	.09	0.6
19332	May 26	V. slight.	Slight.	.18	3.60	.95	.0032	.0074	.0056	.0018	.12	.0070	.0000	.15	0.9
20113	Aug. 16	V. slight.	V. slight.	.14	3.60	.95	.0012	.0044	.0028	.0016	.13	.0080	.0000	.15	1.1
21372	Nov. 23	None.	Slight.	.10	3.40	.75	.0020	.0042	.0038	.0004	.12	.0060	.0001	.08	1.3
Av...	....	....	....	.11	3.59	.90	.0016	.0050	.0037	.0013	.12	.0077	.0000	.12	1.0

Odor of the first and third samples, faintly vegetable; of the others, none.—— The samples were collected from the reservoir.

Water Supply of Clinton and Lancaster.

Chemical Examination of Water from Faucets in Clinton.

[Parts per 100,000.]

Number.	Date of Collection.	Appearance. Turbidity.	Appearance. Sediment.	Appearance. Color.	Residue on Evaporation. Total.	Residue on Evaporation. Loss on Ignition.	Ammonia. Free.	Ammonia. Albuminoid. Total.	Ammonia. Albuminoid. Dissolved.	Ammonia. Albuminoid. Suspended.	Chlorine.	Nitrogen as Nitrates.	Nitrogen as Nitrites.	Oxygen Consumed.	Hardness.
	1897.														
18602	Feb. 23	V. slight.	V. slight.	.07	4.50	1.15	.0030	.0046	.0046	.0000	.11	.0050	.0000	.16	2.3
19682	June 29	None.	None.	.12	4.55	1.60	.0006	.0100	.0076	.0024	.14	.0030	.0000	.27	1.8
21090	Nov. 9	V. slight.	Slight.	.36	4.45	1.55	.0022	.0262	.0252	.0010	.27	.0060	.0000	.38	2.1
Av...	....	....	....	.18	4.50	1.43	.0019	.0136	.0125	.0011	.17	.0047	.0000	.27	2.1

Odor, vegetable, and of the first sample also mouldy.—— The samples were collected from faucets in the town. At the time the last sample was collected no water was being drawn from the "basin;" the other samples represent a mixture of water from all of the sources.

Water Supply of Cohasset. — Cohasset Water Company.

Chemical Examination of Water from the Tubular Wells of the Cohasset Water Company.

[Parts per 100,000.]

Number.	Date of Collection.	Appearance. Turbidity.	Appearance. Sediment.	Appearance. Color.	Residue on Evaporation.	Ammonia. Free.	Ammonia. Albuminoid.	Chlorine.	Nitrogen as Nitrates.	Nitrogen as Nitrites.	Oxygen Consumed.	Hardness.	Iron.
	1897.												
18354	Jan. 26	Slight, milky.	V. slight.	.05	17.30	.0002	.0028	2.29	.0280	.0000	.03	6.4	.0350
18699	Mar. 3	Slight, milky.	V. slight.	.20	16.60	.0002	.0018	2.32	.0200	.0000	.10	6.3	.0480
19211	May 11	Distinct, milky.	Slight, clayey.	.20	13.60	.0000	.0020	2.09	.0280	.0000	.02	6.3	.0350
19725	July 7	Slight.	V. slight.	.15	14.00	.0012	.0030	2.00	.0150	.0000	.02	6.6	.0270
20385	Sept. 8	Slight, milky.	V. slight.	.25	15.40	.0004	.0020	2.06	.0350	.0000	.06	6.9	.0250
21105	Nov. 10	Decided.	None.	.30	14.90	.0008	.0024	1.99	.0340	.0001	.01	8.0	.0300

Averages by Years.

Number.	Year.	Turbidity.	Sediment.	Color.	Residue on Evaporation.	Ammonia. Free.	Ammonia. Albuminoid.	Chlorine.	Nitrates.	Nitrites.	Oxygen Consumed.	Hardness.	Iron.
-	1888	-	-	.01	15.20	.0001	.0021	1.50	.0311	.0003	-	-	-
-	1893	-	-	.16	17.14	.0001	.0007	1.64	.0263	.0001	.04	8.6	.0451
-	1894	-	-	.17	17.94	.0004	.0016	1.77	.0204	.0000	.03	8.4	.0743
-	1895	-	-	.19	17.22	.0002	.0015	1.89	.0211	.0000	.03	8.3	.0689
-	1896	-	-	.16	16.10	.0004	.0018	2.05	.0113	.0000	.09	7.9	.0652
-	1897	-	-	.19	15.30	.0005	.0023	2.12	.0267	.0000	.04	6.7	.0333

Note to analyses of 1897: Odor of the first sample, faintly mouldy, disappearing on heating; of the last, faintly earthy; of the others, none.—— The samples were collected from a faucet at the pumping station, while pumping.

Microscopical Examination.

The organism *Crenothrix* was found in some of these samples, the greatest amount found being 2,500 per cubic centimeter in the sample collected in July.

CONCORD.

WATER SUPPLY OF CONCORD AND LINCOLN.

The organism *Uroglena* appeared in the water of Sandy Pond in the winter and early spring of 1897, imparting to it a disagreeable taste and odor.

Chemical Examination of Water from Sandy Pond, Lincoln.

[Parts per 100,000.]

Number.	Date of Collection.	Appearance.			Residue on Evaporation.		Ammonia.				Chlorine.	Nitrogen as		Oxygen Consumed.	Hardness.
		Turbidity.	Sediment.	Color.	Total.	Loss on Ignition.	Free.	Albuminoid. Total.	Albuminoid. Dissolved.	Albuminoid. Sus-pended.		Nitrates.	Nitrites.		
	1897.														
18383	Jan. 27	V. slight.	V. slight.	.03	2.55	0.90	.0002	.0136	.0122	.0014	.29	.0030	.0000	.23	0.9
18439	Feb. 8	V. slight.	V. slight.	.05	2.50	0.40	.0020	.0206	.0162	.0044	.27	.0000	.0000	.14	1.1
18712	Mar. 8	V. slight.	V. slight.	.03	1.85	0.45	.0018	.0080	.0074	.0006	.20	.0000	.0000	.15	0.5
19031	Apr. 14	V. slight.	V. slight.	.10	2.80	0.65	.0006	.0124	.0104	.0020	.28	.0030	.0000	.18	0.8
19200	May 10	V. slight.	V. slight.	.10	2.70	0.75	.0004	.0096	.0086	.0010	.27	.0130	.0000	.15	1.3
19478	June 16	None.	None.	.06	3.10	0.65	.0000	.0108	.0070	.0038	.23	.0150	.0000	.17	1.3
19759	July 12	None.	V. slight.	.03	2.80	0.90	.0006	.0120	.0108	.0012	.27	.0030	.0000	.18	1.6
20019	Aug. 9	V. slight.	Slight.	.07	3.10	1.15	.0008	.0110	.0100	.0010	.26	.0030	.0000	.19	1.3
20471	Sept. 13	None.	None.	.03	2.70	1.15	.0000	.0100	.0094	.0006	.30	.0020	.0000	.15	0.9
20757	Oct. 11	None.	None.	.00	2.90	1.30	.0010	.0190	.0112	.0078	.28	.0030	.0000	.14	1.3
21059	Nov. 8	None.	None.	.08	2.85	1.00	.0008	.0124	.0124	.0000	.28	.0030	.0000	.12	1.2
21514	Dec. 13	V. slight.	V. slight.	.08	2.70	0.75	.0004	.0128	.0118	.0010	.30	.0120	.0000	.13	1.3
Av...	....	....	....	.05	2.71	0.84	.0007	.0127	.0106	.0021	.27	.0050	.0000	.16	1.1

Odor, generally faintly vegetable, seldom none; in February and April, fishy and oily. On heating, the odor became somewhat stronger.——Nos. 18383 and 18712 were collected from the pond; the others were collected from a faucet in the town.

Microscopical Examination of Water from Sandy Pond, Lincoln.

[Number of organisms per cubic centimeter.]

	1897.											
	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
Day of examination,	30	9	9	15	11	18	15	9	15	13	9	14
Number of sample,	18383	18439	18712	19031	19200	19478	19759	20019	20471	20757	21059	21514
PLANTS.												
Diatomaceæ,	40	10	8	23	15	21	1	6	2	21	3	100
Asterionella,	0	0	0	17	3	1	0	0	0	15	2	88
Cyanophyceæ, Anabæna,	0	0	0	0	1	4	0	0	0	0	0	2
Algæ,	20	8	6	0	0	0	0	0	1	12	0	22
Fungi, Crenothrix,	0	0	0	0	10	0	0	0	0	0	0	0

CONCORD.

Microscopical Examination of Water from Sandy Pond, Lincoln — Concluded.

[Number of organisms per cubic centimeter.]

	1897.											
	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
ANIMALS.												
Infusoria,	28	16	4	12	25	0	1	1	0	0	8	14
Dinobryon,	18	14	0	0	25	0	0	0	0	0	8	14
Uroglena,	8	0	1	10	0	0	0	0	0	0	0	0
Vermes,	0	0	1	0	0	1	0	1	1	0	0	0
Miscellaneous, Zoöglœa,	0	0	0	0	0	5	0	10	0	5	0	5
TOTAL,	88	34	19	35	51	31	2	18	4	38	11	143

WATER SUPPLY OF COTTAGE CITY. — COTTAGE CITY WATER COMPANY.

Chemical Examination of Water from the Springs of the Cottage City Water Company.

[Parts per 100,000.]

Number.	Date of Collection.	Appearance.			Residue on Evaporation.	Ammonia.		Chlorine.	Nitrogen as		Oxygen Consumed.	Hardness.	Iron.
		Turbidity.	Sediment.	Color.		Free.	Albuminoid.		Nitrates.	Nitrites.			
20279	1897. Aug. 24	None.	None.	.01	4.50	.0006	.0012	.99	.0200	.0000	.03	0.9	.0080

Odor, none. —— The sample was collected from a faucet at the pumping station.

WATER SUPPLY OF DALTON FIRE DISTRICT, DALTON.

Chemical Examination of Water from the Lower Reservoir on Egypt Brook.

[Parts per 100,000.]

Number.	Date of Collection.	Appearance.			Residue on Evaporation.		Ammonia.				Chlorine.	Nitrogen as		Oxygen Consumed.	Hardness.
								Albuminoid.							
		Turbidity.	Sediment.	Color.	Total.	Loss on Ignition.	Free.	Total.	Dissolved.	Suspended.		Nitrates.	Nitrites.		
19939	1897. July 27	None.	V. slight.	.66	3.60	1.55	.0006	.0126	.0110	.0016	.05	.0000	.0000	.90	1.0

Odor, distinctly vegetable. —— The sample was collected from the reservoir.

Microscopical Examination.

The total number of organisms per cubic centimeter found in this sample was 156, consisting chiefly of *Dinobryon*.

DALTON.

Chemical Examination of Water from the Upper Reservoir on Egypt Brook.

[Parts per 100,000.]

Number.	Date of Collection.	Appearance.			Residue on Evaporation.		Ammonia.				Chlorine.	Nitrogen as		Oxygen Consumed.	Hardness.
		Turbidity.	Sediment.	Color.	Total.	Loss on Ignition.	Free.	Albuminoid. Total.	Albuminoid. Dissolved.	Albuminoid. Suspended.		Nitrates.	Nitrites.		
	1897.														
19938	July 27	None.	V. slight.	.66	3.45	1.75	.0004	.0132	.0122	.0010	.06	.0120	.0000	1.02	0.5

Odor, faintly vegetable.——The sample was collected from the reservoir.

Microscopical Examination.

The total number of organisms per cubic centimeter found in this sample was 110, consisting chiefly of *Dinobryon*.

Water Supply of Danvers and Middleton.

Chemical Examination of Water from Middleton Pond, Middleton.

[Parts per 100,000.]

Number.	Date of Collection.	Appearance.			Residue on Evaporation.		Ammonia.				Chlorine.	Nitrogen as		Oxygen Consumed.	Hardness.
		Turbidity.	Sediment.	Color.	Total.	Loss on Ignition.	Free.	Albuminoid. Total.	Albuminoid. Dissolved.	Albuminoid. Suspended.		Nitrates.	Nitrites.		
	1897.														
18694	Mar. 2	V. slight.	V. slight.	0.80	4.25	1.95	.0004	.0200	.0194	.0006	.45	.0030	.0000	.88	1.2
19600	June 29	None.	Slight.	1.00	3.80	1.75	.0000	.0236	.0222	.0014	.27	.0030	.0000	.95	0.9
20396	Sept. 8	Slight.	V. slight.	0.60	4.05	1.70	.0010	.0200	.0186	.0014	.37	.0000	.0000	.80	1.3
21463	Dec. 7	V. slight.	Cons.	0.60	4.10	1.80	.0004	.0238	.0222	.0016	.40	.0050	.0000	.71	1.8
Av...	....	....	....	0.75	4.05	1.80	.0004	.0218	.0206	.0012	.37	.0027	.0000	.83	1.3

Odor, distinctly vegetable.——Nos. 19600 and 20396 were collected from the pond; the others, from a faucet at the pumping station.

Microscopical Examination of Water from Middleton Pond, Middleton.

[Number of organisms per cubic centimeter.]

	1897. March.	1897. July.	1897. September.	1897. December.
Day of examination,	5	3	9	8
Number of sample,	18694	19600	20396	21463
PLANTS.				
Diatomaceæ,	2	446	555	3,466
Asterionella,	0	56	548	2,640
Cyclotella,	0	272	1	40
Tabellaria,	0	110	0	776

DANVERS.

Microscopical Examination of Water from Middleton Pond, Middleton — Concluded.

[Number of organisms per cubic centimeter.]

	1897.			
	March.	July.	September.	December.
PLANTS — Con.				
Cyanophyceæ,	0	12	71	0
Anabæna,	0	8	20	0
Cœlosphærium,	0	0	46	0
Algæ,	0	10	19	26
ANIMALS.				
Infusoria,	290	4	0	20
Dinobryon,	288	0	0	16
Vermes, Asplanchna,	1	0	0	0
Miscellaneous, Zoöglœa,	0	15	3	5
TOTAL,	293	487	648	3,517

Water Supply of Danvers Lunatic Hospital.

The advice of the State Board of Health to the superintendent of the Danvers Lunatic Hospital, with reference to a proposed new source of water supply for the hospital, may be found on page 9 of this volume. The results of an analysis of a sample of water from a test well at the place where it was proposed to secure a supply of water from the ground are given in the following table: —

Chemical Examination of Water from a Tubular Test Well at the Danvers Lunatic Hospital.

[Parts per 100,000.]

Number.	Date of Collection.	Appearance.			Residue on Evaporation.	Ammonia.		Chlorine.	Nitrogen as		Oxygen Consumed.	Hardness.	Iron.
		Turbidity	Sediment.	Color.		Free.	Albuminoid.		Nitrates.	Nitrites.			
21044	1897. Nov. 4	V. slight.	Slight.	.03	17.10	.0046	.0054	2.16	.6000	.0020	.12	6.7	.0090

Odor, faintly vegetable. —— The sample was collected from a tubular test well, situated about 4,000 feet west of the hospital, near a small brook which flows into the Ipswich River, about 1,200 feet above the mouth of the brook.

DEDHAM.

Water Supply of Dedham. — Dedham Water Company.

Chemical Examination of Water from the Well of the Dedham Water Company.

[Parts per 100,000.]

Number.	Date of Collection.	Appearance. Turbidity.	Appearance. Sediment.	Appearance. Color.	Residue on Evaporation.	Ammonia. Free.	Ammonia. Albuminoid.	Chlorine.	Nitrogen as Nitrates.	Nitrogen as Nitrites.	Oxygen Consumed.	Hardness.	Iron.
	1897.												
18287	Jan. 19	None.	None.	.00	10.90	.0004	.0028	.88	.2200	.0000	.00	3.9	.0040
18770	Mar. 15	None.	None.	.00	9.90	.0002	.0018	.90	.1500	.0000	.02	4.2	.0030
19262	May 18	None.	None.	.00	8.40	.0000	.0012	.84	.1400	.0000	.02	5.1	.0000
19815	July 19	None.	None.	.00	9.30	.0006	.0026	.80	.2200	.0000	.04	3.9	.0000
20562	Sept. 20	None.	V. slight.	.03	9.20	.0006	.0040	.78	.1200	.0000	.07	3.9	.0020
21321	Nov. 23	None.	None.	.04	8.80	.0032	.0064	.85	.2000	.0000	.03	4.6	.0000
Av.	....	....	....	.01	9.42	.0008	.0031	.84	.1750	.0000	.03	4.3	.0015

Odor, none. —— The samples were collected from a faucet at the pumping station, with the exception of No. 21321, which was collected from a faucet at the office of the water company.

Water Supply of East Bridgewater.

(See *Bridgewater.*)

Water Supply of Easthampton.

Chemical Examination of Water from Bassett Brook, Easthampton.

[Parts per 100,000.]

Number.	Date of Collection.	Appearance. Turbidity.	Appearance. Sediment.	Appearance. Color.	Residue on Evaporation. Total.	Residue on Evaporation. Loss on Ignition.	Ammonia. Free.	Ammonia. Albuminoid. Total.	Ammonia. Albuminoid. Dissolved.	Ammonia. Albuminoid. Suspended.	Chlorine.	Nitrogen as Nitrates.	Nitrogen as Nitrites.	Oxygen Consumed.	Hardness.
	1897.														
18621	Feb. 23	V. slight.	Slight.	.28	3.45	1.30	.0016	.0100	.0072	.0028	.11	.0080	.0000	.27	1.1
19597	June 28	None.	None.	.16	4.05	0.95	.0002	.0070	.0064	.0006	.05	.0070	.0000	.22	1.1
20938	Oct. 23	None.	V. slight.	.37	4.25	1.30	.0004	.0090	.0072	.0018	.17	.0080	.0000	.23	1.4
Av.	....	....	....	.27	3.92	1.18	.0007	.0086	.0069	.0017	.11	.0077	.0000	.24	1.2

Odor of the first sample, distinctly vegetable; of the second, none; of the last, faintly vegetable. —— The samples were collected from a faucet at the pumping station.

WATER SUPPLY OF NORTH EASTON VILLAGE DISTRICT, EASTON.

Chemical Examination of Water from the Well of the North Easton Village District.

[Parts per 100,000.]

Number.	Date of Collection.	Appearance.			Residue on Evaporation.	Ammonia.		Chlorine.	Nitrogen as		Oxygen Consumed.	Hardness.	Iron.
		Turbidity.	Sediment.	Color.		Free.	Albuminoid.		Nitrates.	Nitrites.			
19953	1897. July 28	None.	None.	.00	4.40	.0010	.0024	.57	.0200	.0000	.02	1.7	.0000

Odor, none. —— The sample was collected from a faucet at the pumping station.

EDGARTOWN.

The advice of the State Board of Health to the Edgartown Water Company, with reference to securing a supply of water from the ground at "Wintucket Bottom," may be found on pages 9 and 10 of this volume. The results of an analysis of a sample of water collected from a test well at this place are given in the following table: —

Chemical Examination of Water from a Tubular Test Well in Edgartown.

[Parts per 100,000.]

Number.	Date of Collection.	Appearance.			Residue on Evaporation.	Ammonia.		Chlorine.	Nitrogen as		Oxygen Consumed	Hardness.	Iron.
		Turbidity.	Sediment.	Color.		Free.	Albuminoid.		Nitrates.	Nitrites.			
18760	1897. Mar. 10	V slight.	Slight, sandy.	.00	4.00	.0000	.0010	.98	.0030	.0000	.02	0.2	.0100

Odor, none. —— The sample was collected from a tubular test well in Wintucket Bottom.

WATER SUPPLY OF EVERETT.

(See *Boston, Mystic Works.*)

FAIRHAVEN.

Water Supply of Fairhaven.

The advice of the State Board of Health to Joseph K. Nye, with reference to a proposed water supply for the towns of Wareham, Marion, Mattapoisett and Fairhaven, may be found on pages 47 to 49 of this volume. The results of analyses of samples of water from the sources under consideration may be found in the following table, and also under Wareham in this volume.

Water Supply of Fairhaven. — Fairhaven Water Company.

The advice of the State Board of Health to the board of health of Fairhaven with reference to the presence of lead in the water drawn through lead service pipes in the town, may be found on page 10 of this volume.

Chemical Examination of Water from the Tubular Wells of the Fairhaven Water Company.

[Parts per 100,000.]

Number.	Date of Collection.	Appearance.			Residue on Evaporation.	Ammonia.		Chlorine.	Nitrogen as		Oxygen Consumed.	Hardness.	Iron.
		Turbidity.	Sediment.	Color.		Free.	Albu-minoid.		Nitrates.	Nitrites.			
	1897.												
18336	Jan. 23	None.	None.	.05	5.80	.0010	.0040	1.05	.0480	.0000	.07	1.9	.0200
18524	Feb. 16	None.	None.	.07	4.80	.0002	.0032	1.03	.0450	.0000	.11	1.8	.0280
18769	Mar. 12	None.	None.	.02	6.00	.0002	.0026	1.08	.0400	.0000	.08	1.7	.0030
19099	Apr. 21	None.	None.	.05	5.40	.0000	.0016	0.98	.0470	.0000	.07	1.8	.0080
19258	May 17	None.	None.	.15	4.70	.0000	.0050	0.97	.0380	.0000	.10	1.6	.0000
19461	June 14	None.	V. slight.	.32	5.50	.0006	.0050	0.96	.0380	.0001	.33	1.7	.0250
19827	July 19	None.	None.	.38	6.00	.0006	.0058	1.01	.0280	.0001	.40	2.2	.0060
20295	Aug. 26	V. slight.	V. slight.	.23	6.30	.0004	.0036	0.93	.0400	.0002	.24	1.8	.0240
20631	Sept. 25	None.	V. slight.	.33	5.40	.0000	.0054	0.97	.0250	.0002	.27	2.2	.0250
21031	Nov. 1	None.	None.	.36	6.25	.0010	.0090	1.14	.0230	.0001	.37	2.3	.0050
21348	Nov. 23	Decided.	Slight.	.18	5.45	.0016	.0056	1.02	.0280	.0000	.18	2.1	.0240
21642	Dec. 22	V. slight.	V. slight.	.07	5.10	.0002	.0026	0.98	.0330	.0002	.11	2.1	.0040
Av...	....	....	....	.18	5.56	.0005	.0044	1.01	.0361	.0001	.19	1.9	.0143

Odor, none. A faintly vegetable or earthy odor was developed in some of the samples on heating. —— The samples were collected from a faucet at the pumping station.

WATER SUPPLY OF FALL RIVER.

The advice of the State Board of Health to the city of Fall River, relative to preventing the pollution of the water supply of the city, may be found on pages 10 and 11 of this volume.

Chemical Examination of Water from North Watuppa Lake.

[Parts per 100,000.]

Number.	Date of Collection.	Appearance.			Residue on Evaporation.		Ammonia.				Chlorine.	Nitrogen as		Oxygen Consumed.	Hardness.
		Turbidity.	Sediment.	Color.	Total.	Loss on Ignition.	Free.	Albuminoid. Total.	Albuminoid. Dissolved.	Albuminoid. Suspended.		Nitrates.	Nitrites.		
	1897.														
18629	Feb. 24	V. slight.	V. slight	.35	4.00	1.20	.0010	.0128	.0124	.0004	.64	.0050	.0001	.39	0.9
19300	May 24	V. slight.	V slight.	.30	3.25	0.85	.0006	.0144	.0142	.0002	.60	.0050	.0000	.38	0.5
19994	Aug. 4	None.	V. slight.	.13	3.35	1.20	.0014	.0154	.0134	.0020	.61	.0030	.0000	.35	0.3
21038	Nov. 3	None.	None.	.16	3.40	1.45	.0012	.0152	.0152	.0000	.66	.0000	.0000	.27	1.0

Averages by Years.

-	1887*	-	-	.16	3.26	0.98	.0005	.0151	-	-	.53	.0039	-	-	-
-	1888	-	-	.17	3.18	0.93	.0004	.0158	-	-	.52	.0057	.0001	-	-
-	1889†	-	-	.27	3.30	1.20	.0006	.0164	.0140	.0024	.50	.0076	.0002	-	-
-	1892	-	-	.08	2.95	0.86	.0012	.0130	.0107	.0023	.52	.0117	.0001	-	0.5
-	1894‡	-	-	.25	3.10	1.15	.0007	.0149	.0130	.0019	.53	.0040	.0000	.39	0.5
-	1895§	-	-	.29	3.40	1.17	.0008	.0191	.0161	.0030	.59	.0010	.0000	.45	0.7
-	1896	-	-	.22	3.32	1.14	.0011	.0160	.0137	.0023	.61	.0041	.0000	.35	0.7
-	1897	-	-	.23	3.50	1.17	.0010	.0144	.0138	.0006	.63	.0032	.0000	.35	0.7

* June to December. † January to May.
‡ March and April. § February, April and May.

NOTE to analyses of 1897: Odor of the first three samples, faintly vegetable; of the last, none.—— The samples were collected from faucets in the city. For height of water in this pond, see table on page 163.

FALL RIVER.

Chemical Examination of Water from North Watuppa Lake, collected from Various Parts of the Lake.

Samples collected from the Surface of the Lake, a quarter of a Mile North of the Bridge connecting Fall River and Westport.

[Parts per 100,000.]

Number.	Date of Collection.	Appearance. Turbidity.	Appearance. Sediment.	Appearance. Color.	Residue on Evaporation. Total.	Residue on Evaporation. Loss on Ignition.	Ammonia. Free.	Ammonia. Albuminoid. Total.	Ammonia. Albuminoid. Dissolved	Ammonia. Albuminoid. Suspended.	Chlorine.	Nitrogen as Nitrates.	Nitrogen as Nitrites.	Oxygen Consumed.	Hardness.
	1897.														
19921	July 26	V. slight.	Slight.	.15	3.20	0.80	.0004	.0188	.0158	.0030	.65	.0020	.0000	.41	0.6
20044	Aug. 9	Slight.	V. slight.	.14	3.50	1.35	.0010	.0176	.0152	.0024	.63	.0030	.0000	.35	0.7
20255	Aug. 23	V. slight.	V. slight	.14	3.35	1.15	.0006	.0168	.0132	.0036	.62	.0020	.0000	.30	0.8
20422	Sept. 8	V. slight.	V. slight.	.18	3.55	1.20	.0000	.0170	.0144	.0026	.65	.0020	.0000	.33	0.6
20575	Sept. 20	V. slight.	V. slight.	.18	3.45	1.50	.0006	.0160	.0158	.0002	.62	.0020	.0000	.35	0.6
20868	Oct. 18	V. slight.	Slight.	.30	3.40	1.20	.0002	.0144	.0122	.0022	.64	.0250	.0000	.39	0.8
21327	Nov. 22	V. slight.	Cons.	.19	3.45	1.20	.0014	.0184	.0174	.0010	.66	.0030	.0000	.33	1.1
21634	Dec. 22	Slight.	Slight.	.20	3.80	1.55	.0004	.0190	.0168	.0022	.68	.0050	.0002	.43	0.8

Samples collected from the Surface of the Lake, midway between Wilson Road and Spencer Borden's Point.

Number.	Date of Collection.	Turbidity.	Sediment.	Color.	Total.	Loss on Ignition.	Free.	Total.	Dissolved	Suspended.	Chlorine.	Nitrates.	Nitrites.	Oxygen Consumed.	Hardness.
19922	July 26	V. slight.	Slight.	.16	3.20	0.85	.0006	.0176	.0128	.0048	.68	.0030	.0000	.44	0.6
20045	Aug. 9	Slight.	Slight.	.13	3.60	1.40	.0008	.0186	.0140	.0046	.60	.0020	.0000	.39	0.6
20256	Aug. 23	V. slight.	V. slight.	.16	3.55	1.45	.0008	.0200	.0152	.0048	.63	.0030	.0000	.37	0.6
20423	Sept. 8	V. slight.	Slight.	.20	3.60	1.20	.0000	.0182	.0154	.0028	.65	.0020	.0000	.39	0.6
20576	Sept. 20	V. slight.	Slight.	.18	3.65	1.60	.0004	.0172	.0132	.0040	.61	.0000	.0000	.36	0.5
20869	Oct. 18	V. slight.	Slight.	.30	3.55	1.45	.0004	.0116	.0116	.0000	.67	.0250	.0000	.39	1.7
21328	Nov. 22	V slight.	Decided.	.31	3.45	1.60	.0012	.0196	.0186	.0010	.66	.0020	.0001	.44	1.0
21635	Dec. 22	Slight.	Slight.	.41	3.55	1.75	.0004	.0174	.0160	.0014	.66	.0070	.0001	.52	1.1

Samples collected from the Surface of the Lake, midway between Spencer Borden's Point and Ralph's Neck.

Number.	Date of Collection.	Turbidity.	Sediment.	Color.	Total.	Loss on Ignition.	Free.	Total.	Dissolved	Suspended.	Chlorine.	Nitrates.	Nitrites.	Oxygen Consumed.	Hardness.
19923	July 26	V. slight.	Slight.	.15	3.10	0.85	.0000	.0176	.0142	.0034	.67	.0000	.0000	.41	0.6
20046	Aug. 9	Slight.	Slight.	.14	3.55	1.35	.0008	.0186	.0130	.0056	.60	.0000	.0000	.37	0.6
20257	Aug. 23	V. slight.	V. slight.	.14	3.45	1.20	.0012	.0186	.0146	.0040	.61	.0020	.0000	.31	0.6
20424	Sept. 8	V. slight.	V. slight	.18	3.40	1.05	.0002	.0196	.0158	.0038	.60	.0020	.0000	.32	0.6
20577	Sept. 20	V. slight.	V. slight.	.18	3.45	1.45	.0004	.0158	.0156	.0002	.62	.0000	.0000	.39	1.3
20870	Oct. 18	V. slight.	Slight.	.28	3.55	1.40	.0008	.0108	.0090	.0018	.68	.0100	.0000	.40	1.1
21330	Nov. 22	V. slight	Slight.	.37	3.50	1.60	.0016	.0196	.0180	.0016	.66	.0030	.0000	.40	1.0
21636	Dec. 22	Slight.	Slight.	.33	3.75	1.80	.0006	.0178	.0172	.0006	.65	.0020	.0001	.46	1.4

Samples collected from the Bottom of the Lake, midway between Spencer Borden's Point and Ralph's Neck.

Number.	Date of Collection.	Turbidity.	Sediment.	Color.	Total.	Loss on Ignition.	Free.	Total.	Dissolved	Suspended.	Chlorine.	Nitrates.	Nitrites.	Oxygen Consumed.	Hardness.
19924	July 26	V. slight.	Slight.	.15	3.20	0.80	.0000	.0196	.0148	.0048	.64	.0000	.0000	.39	0.6
20047	Aug. 9	Slight.	Slight.	.14	3.45	1.25	.0008	.0170	.0136	.0034	.64	.0020	.0000	.37	0.6
20258	Aug. 23	V. slight.	V. slight.	.14	3.10	0.95	.0008	.0170	.0146	.0026	.61	.0030	.0000	.31	0.6
20425	Sept. 8	V. slight.	Slight.	.18	3.55	1.00	.0002	.0166	.0166	.0000	.61	.0020	.0000	.34	0.6
20578	Sept. 20	V. slight.	V. slight.	.25	3.40	1.50	.0008	.0166	.0164	.0002	.60	.0020	.0000	.36	0.5
20871	Oct. 18	V. slight.	Slight.	.30	3.50	1.45	.0004	.0130	.0130	.0000	.64	.0430	.0000	.34	0.5
21329	Nov. 22	V. slight.	Cons.	.31	3.35	1.40	.0018	.0194	.0186	.0008	.66	.0030	.0000	.40	0.8
21637	Dec. 22	Slight.	Slight.	.37	3.60	1.60	.0006	.0186	.0158	.0028	.80	.0030	.0001	.52	0.8

Odor, generally faintly vegetable.

Microscopical Examination.

In the samples collected in July the organisms *Microcystis* and *Nostoc* were found in considerable numbers. An insignificant number of organisms was found in each of the other samples.

FALL RIVER.

Chemical Examination of Water from South Watuppa Lake, collected from Various Parts of the Lake.

Samples collected from the Surface of the Lake, at the Sand Bar.

[Parts per 100,000.]

Number.	Date of Collection.	Appearance. Turbidity.	Appearance. Sediment.	Appearance. Color.	Residue on Evaporation. Total.	Residue on Evaporation. Loss on Ignition.	Ammonia. Free.	Ammonia. Albuminoid. Total.	Ammonia. Albuminoid. Dissolved.	Ammonia. Albuminoid. Suspended.	Chlorine.	Nitrogen as Nitrates.	Nitrogen as Nitrites.	Oxygen Consumed.	Hardness.
	1897.														
19925	July 26	V. slight.	V. slight.	.18	4.90	1.50	.0034	.0222	.0174	.0048	.87	.0220	.0000	.44	1.7
20048	Aug. 9	V. slight.	Slight.	.18	5.80	1.90	.0018	.0198	.0146	.0052	.83	.0030	.0000	.40	1.6
20259	Aug. 23	V. slight.	V. slight.	.17	5.05	1.55	.0008	.0212	0148	.0064	.84	.0030	.0000	.37	1.6
20426	Sept. 8	V. slight.	V. slight.	.25	5.40	1.65	.0006	.0204	.0190	.0014	.83	.0020	.0000	.44	1.7
20579	Sept. 20	V. slight.	V. slight.	.23	5.35	1.80	.0012	.0182	.0178	.0004	.84	.0000	.0000	.45	1.6
20872	Oct. 18	V. slight.	V. slight.	.30	5.75	1.80	.0006	.0182	.0126	.0056	.87	.0300	.0000	.40	2.6
21331	Nov. 22	Slight.	Slight.	.39	5.95	2.15	.0024	.0252	.0234	.0018	.88	.0030	.0003	.49	2.0
21654	Dec. 23	V. slight.	V. slight.	.42	5.90	1.95	.0022	.0238	.0222	.0016	.93	.0050	.0001	.46	2.3

Samples collected from the Surface of the Lake, near the Entrance of the Brook from Sawdy Pond.

19926	July 26	Slight.	Slight.	.18	4.80	1.40	.0010	.0202	.0164	.0038	.83	.0030	.0000	.44	1.7
20051	Aug. 9	Slight.	Slight.	.18	5.40	1.65	.0018	.0204	.0174	.0030	.84	.0030	.0000	.42	1.6
20262	Aug. 23	V. slight.	V. slight.	.21	5.15	1.45	.0010	.0182	.0148	.0034	.81	.0030	.0000	.40	1.4
20427	Sept. 8	V. slight.	V. slight.	.35	4.65	1.95	.0000	.0204	.0192	.0012	.76	.0030	.0000	.52	1.4
20582	Sept. 20	V. slight.	V. slight.	.25	5.40	1.85	.0006	.0158	.0158	.0000	.78	.0000	.0000	.42	1.3
20875	Oct. 18	Slight.	Cons.	.25	5.25	1.50	.0002	.0222	.0200	.0022	.85	.0180	.0000	.40	1.6
21334	Nov. 22	V. slight.	Cons.	.41	5.20	1.85	.0018	.0218	.0214	.0004	.84	.0010	.0001	.54	1.7
21657	Dec. 23	V. slight.	Slight.	.49	5.00	2.05	.0012	.0230	.0210	.0020	.78	.0050	.0001	.59	1.7

Samples collected from the Surface of the Lake, at the Line between Massachusetts and Rhode Island.

19927	July 26	V. slight.	V. slight.	.17	4.80	1.40	.0008	.0186	.0152	.0034	.83	.0030	.0000	.43	1.8
20049	Aug. 9	Slight.	V. slight.	.16	5.60	1.65	.0008	.0190	.0148	.0042	.83	.0020	.0000	.42	1.5
20260	Aug. 23	V. slight.	V. slight.	.18	4.95	1.25	.0006	.0186	.0146	.0040	.86	.0020	.0000	.39	1.4
20428	Sept. 8	V. slight.	V. slight.	.30	5.15	1.50	.0000	.0190	.0182	.0008	.84	.0020	.0000	.40	1.7
20580	Sept. 20	V. slight.	V. slight.	.25	5.30	1.65	.0020	.0172	.0170	.0002	.84	.0000	.0000	.44	1.6
20873	Oct. 18	V. slight.	V. slight.	.30	5.70	1.75	.0006	.0178	.0178	.0000	.86	.0120	.0000	.42	1.7
21332	Nov. 22	V. slight.	Slight.	.37	5.70	1.70	.0042	.0266	.0250	.0016	.90	.0030	.0003	.49	2.1
21655	Dec. 23	V. slight.	V. slight.	.46	5.75	2.00	.0020	.0240	.0236	.0004	.89	.0040	.0002	.52	2.0

Samples collected from the Bottom of the Lake, at the Line between Massachusetts and Rhode Island.

19928	July 26	Slight.	Slight.	.20	4.75	1.25	.0012	.0190	.0178	.0012	.87	.0050	.0000	.43	1.7
20050	Aug. 9	Slight.	V. slight.	.18	5.10	1.35	.0018	.0192	.0144	.0048	.88	.0000	.0000	.42	1.7
20261	Aug. 23	V. slight.	V. slight.	.18	5.45	1.60	.0008	.0178	.0148	.0030	.88	.0030	.0000	.37	1.7
20429	Sept. 8	V. slight.	V. slight.	.30	5.10	1.75	.0002	.0186	.0164	.0022	.85	.0020	.0000	.43	1.7
20581	Sept. 20	V. slight.	V. slight.	.25	5.50	1.80	.0010	.0164	.0164	.0000	.84	.0000	.0000	.45	1.6
20874	Oct. 18	V. slight.	Slight.	.22	4.90	1.65	.0006	.0172	.0146	.0026	.84	.0250	.0000	.51	1.7
21333	Nov. 22	Slight.	Slight.	.35	5.60	1.75	.0032	.0222	.0214	.0008	.86	.0020	.0001	.48	2.1
21656	Dec. 23	V. slight.	V. slight.	.40	5.75	2.05	.0022	.0232	.0220	.0012	.91	.0070	.0002	.54	2.1

FALL RIVER.

Chemical Examination of Water from South Watuppa Lake, collected from Various Parts of the Lake — Concluded.

Samples collected from the Quequechan River, where it is crossed by the Plymouth Avenue Bridge.

[Parts per 100,000.]

Number.	Date of Collection.	Appearance.			Residue on Evaporation.		Ammonia.				Chlorine.	Nitrogen as		Oxygen Consumed.	Hardness.
		Turbidity.	Sediment.	Color.	Total.	Loss on Ignition.	Free.	Albuminoid. Total.	Albuminoid. Dissolved.	Albuminoid. Suspended.		Nitrates.	Nitrites.		
	1897.														
19932	July 26	Distinct.	Cons.	.18	6.55	1.65	.0400	.0304	.0256	.0048	1.16	.0050	.0018	.42	2.0
20055	Aug. 9	Distinct.	Slight.	.18	7.05	1.55	.0350	.0296	.0252	.0044	1.29	.0030	.0009	.43	1.9
20266	Aug. 23	Slight.	Slight.	.18	7.25	1.75	.0354	.0284	.0252	.0032	1.20	.0050	.0016	.36	2.2
20433	Sept. 8	V. slight.	Cons.	.30	6.70	1.65	.0436	.0302	.0260	.0042	1.21	.0030	.0015	.40	2.3
20586	Sept. 20	V. slight.	Slight.	.20	6.85	1.75	.0154	.0292	.0218	.0074	1.16	.0030	.0015	.41	1.7
20879	Oct. 18	Slight.	Cons.	.32	7.80	2.10	.0388	.0316	.0238	.0078	1.38	.0180	.0020	.43	2.3
21338	Nov. 22	Decided.	Cons.	.40	7.35	2.15	.0724	.0336	.0310	.0026	1.19	.0170	.0014	.52	3.0
21641	Dec. 22	Decided.	Cons.	.41	7.25	2.25	.0506	.0320	.0284	.0036	1.22	.0190	.0012	.52	2.5

Odor, vegetable, sometimes mouldy or musty, and occasionally also unpleasant.

Microscopical Examination.

In the samples collected in July considerable numbers of the organisms *Merismopœdia* and *Microcystis* were found. An insignificant number of organisms was found in each of the other samples.

Chemical Examination of Water from the Tributaries of North Watuppa Lake.

[Parts per 100,000.]

Number.	Date of Collection.	Appearance.			Residue on Evaporation.		Ammonia.				Chlorine.	Nitrogen as		Oxygen Consumed.	Hardness.
		Turbidity.	Sediment.	Color.	Total.	Loss on Ignition.	Free.	Albuminoid. Total.	Albuminoid. Dissolved.	Albuminoid. Suspended.		Nitrates.	Nitrites.		
	1897.														
18998	Apr. 12	Distinct.	Slight.	0.50	7.50	2.40	.0012	.0276	.0246	.0030	1.00	.0680	.0010	0.54	2.2
18999	Apr. 12	V. slight.	V. slight.	1.30	5.20	2.55	.0006	.0200	.0200	.0000	0.55	.0270	.0000	1.04	0.8
19000	Apr. 12	V. slight.	V. slight.	1.30	3.85	1.70	.0006	.0200	.0188	.0012	0.42	.0050	.0000	1.17	0.6
19001	Apr. 12	V. slight.	V. slight.	2.55	5.60	3.80	.0006	.0258	.0256	.0002	0.37	.0030	.0001	1.98	0.6
19002	Apr. 12	V. slight.	V slight.	1.80	5.35	2.75	.0008	.0336	.0330	.0006	0.69	.0100	.0001	1.57	0.6
19003	Apr. 12	V. slight.	V. slight.	1.30	8.25	2.55	.0012	.0420	.0406	.0014	1.57	.0050	.0001	1.07	1.8

Odor, distinctly vegetable, sometimes mouldy. —— The samples were collected from tributaries of the lake, as follows: No. 18998, from Cress Brook, near its mouth; No. 18999, from Highland Brook, a short distance below New Boston Road; No. 19000, from Terry's Brook, near its mouth; No. 19001, from Blossom Brook, a short distance below Blossom Road; No. 19002, from Ralph Brook, just above its mouth; No. 19003, from the north branch of Nat Brook, a short distance above its junction with the east branch.

FALL RIVER.

Chemical Examination of Water from Stafford Pond, in Tiverton, R. I.

[Parts per 100,000.]

Number.	Date of Collection.	Appearance.			Residue on Evaporation.		Ammonia.				Chlorine.	Nitrogen as		Oxygen Consumed.	Hardness.
		Turbidity.	Sediment.	Color.	Total.	Loss on Ignition.	Free.	Albuminoid. Total.	Albuminoid. Dissolved.	Albuminoid. Suspended.		Nitrates.	Nitrites		
	1897.														
19931	July 26	Distinct.	Slight.	.07	3.15	0.80	.0006	.0164	.0140	.0024	.71	.0000	.0000	.19	0.3
20053	Aug. 9	Slight.	Slight.	.12	3.10	1.00	.0012	.0144	.0100	.0044	.71	.0020	.0000	.17	0.3
20264	Aug. 23	Slight.	V slight.	.06	3.10	1.00	.0008	.0144	.0112	.0032	.58	.0000	.0000	.16	0.5
20431	Sept. 8	V. slight.	V. slight.	.08	2.90	0.95	.0000	.0168	.0142	.0026	.79	.0020	.0000	.16	0.6
20585	Sept. 20	V. slight.	V. slight.	.10	3.00	1.05	.0018	.0164	.0136	.0028	.56	.0020	.0000	.19	0.3
20878	Oct. 18	V. slight, milky.	V. slight.	.10	3.40	1.35	.0016	.0178	.0152	.0026	.60	.0200	.0000	.16	1.1
21337	Nov. 22	Decided.	Cons.	.20	3.25	1.10	.0010	.0184	.0172	.0012	.64	.0020	.0001	.23	0.6
21640	Dec. 22	Decided.	Slight.	.14	3.10	1.35	.0006	.0170	.0162	.0008	.62	.0030	.0001	.18	0.8
Av.*	....	....	....	.11	3.16	1.10	.0009	.0168	.0145	.0023	.65	.0045	.0000	.18	0.6

* Where more than one sample was collected in a month, the mean analysis for that month has been used in making the average.

Odor of No. 21640, none; of No. 21337, none, becoming faintly vegetable on heating; of the others, generally faintly vegetable, becoming somewhat stronger on heating. —— The samples were collected from the pond, at the surface.

Microscopical Examination of Water from Stafford Pond, in Tiverton, R. I.

[Number of organisms per cubic centimeter.]

	1897. July.	Aug.	Aug	Sept	Sept.	Oct.	Nov.	Dec.
Day of examination,	29	12	25	10	21	20	24	24
Number of sample,	19931	20053	20264	20431	20585	20878	21337	21640
PLANTS.								
Diatomaceæ,	192	518	356	634	468	134	103	64
Asterionella,	52	52	38	580	460	1	20	37
Tabellaria,	136	452	312	0	0	132	77	21
Cyanophyceæ,	32	0	120	14	12	20	0	0
Anabæna,	0	0	24	0	0	7	0	0
Merismopœdia,	30	0	96	14	12	0	0	0
Microcystis,	2	0	0	0	0	13	0	0
Algæ,	0	32	10	8	0	0	23	0
ANIMALS.								
Infusoria,	0	2	2	0	0	0	3	2
Crustacea, Cyclops,	0	0	0	0	pr.	0	0	0
Miscellaneous, Zoöglœa,	30	8	15	2	3	7	3	0
Total,	254	560	503	658	483	161	132	66

FALL RIVER.

Chemical Examination of Water from Sawdy Pond, in Westport.

[Parts per 100,000.]

Number.	Date of Collection.	Appearance.			Residue on Evaporation.		Ammonia.				Chlorine.	Nitrogen as		Oxygen Consumed.	Hardness.
		Turbidity.	Sediment.	Color.	Total.	Loss on Ignition.	Free.	Albuminoid. Total.	Albuminoid. Dissolved.	Albuminoid. Suspended.		Nitrates.	Nitrites.		
	1897.														
19929	July 26	Slight.	Slight	.12	2.95	1.10	.0020	.0218	.0172	.0046	.69	.0020	.0000	.37	0.5
20052	Aug. 9	Slight.	V. slight	.14	3.20	1.10	.0016	.0210	.0182	.0028	.61	.0030	.0000	.39	0.5
20263	Aug. 23	V. slight.	V. slight	.28	3.60	1.35	.0006	.0218	.0186	.0032	.57	.0020	.0000	.47	0.5
20432	Sept. 8	V. slight	V. slight.	.70	4.35	2.15	.0002	.0266	.0252	.0014	.60	.0020	.0000	.91	0.9
20583	Sept. 20	V. slight.	V slight.	.25	3.90	1.70	.0020	.0270	.0248	.0022	.59	.0020	.0000	.45	0.3
20876	Oct. 18	V. slight.	Slight.	.20	3.85	1.55	.0002	.0202	.0188	.0014	.60	.0420	.0000	.35	0.5
21335	Nov 22	Decided.	Cons.	.47	4.00	1.60	.0010	.0222	.0208	.0014	.70	.0020	.0001	.51	0.8
21638	Dec. 22	Decided.	Cons.	.49	3.70	1.75	.0010	.0232	.0220	.0012	.64	.0010	.0001	.67	0.8
Av.*.	....	....	....	.33	3.67	1.52	.0011	.0226	.0204	.0022	.63	.0086	.0000	.50	0.6

* Where more than one sample was collected in a month, the mean analysis for that month has been used in making the average.

Odor of No. 21638, none; of the others, faintly vegetable, becoming somewhat stronger on heating. —— The samples were collected from the pond, at the surface.

Chemical Examination of Water from Devol Pond, Westport.

[Parts per 100,000.]

Number.	Date of Collection.	Appearance.			Residue on Evaporation.		Ammonia.				Chlorine.	Nitrogen as		Oxygen Consumed.	Hardness.
		Turbidity.	Sediment.	Color.	Total.	Loss on Ignition.	Free.	Albuminoid. Total.	Albuminoid. Dissolved.	Albuminoid. Suspended.		Nitrates.	Nitrites.		
	1897.														
19930	July 26	Slight.	Slight.	0.42	3.65	1.50	.0000	.0220	.0196	.0024	.67	.0050	.0000	.62	0.6
20054	Aug. 9	Slight.	Slight.	0.46	4.45	1.55	.0012	.0214	.0198	.0016	.60	.0000	.0000	.63	0.6
20265	Aug. 23	V. slight.	V. slight.	0.74	4.30	1.90	.0012	.0232	.0220	.0012	.57	.0020	.0000	.84	0.6
20430	Sept. 8	Slight.	V. slight.	0.40	3.55	1.75	.0006	.0274	.0212	.0062	.62	.0030	.0000	.52	0.8
20584	Sept. 20	V slight.	V. slight	0.65	4.65	2.20	.0014	.0254	.0246	.0008	.59	.0020	.0000	.86	0.5
20877	Oct. 18	V. slight.	V slight.	0.50	4.90	2.35	.0000	.0252	.0238	.0014	.58	.0280	.0000	.31	1.1
21336	Nov. 22	V. slight.	Slight.	0.90	4.70	2.15	.0016	.0288	.0278	.0010	.73	.0030	.0001	.86	1.1
21639	Dec. 22	V. slight.	V. slight.	1.07	4.35	2.25	.0008	.0276	.0264	.0012	.60	.0050	.0001	.90	1.0
Av.*.	....	....	....	0.67	4.34	1.99	.0008	.0254	.0236	.0018	.63	.0074	.0000	.68	0.8

* Where more than one sample was collected in a month, the mean analysis for that month has been used in making the average.

Odor of No. 21639, none, becoming faintly vegetable on heating; of the others, generally faintly vegetable, becoming somewhat stronger on heating. —— The samples were collected from the pond, at the surface.

FALL RIVER.

Table showing Heights of Water in North Watuppa Lake on the First of Each Month in 1897.

[Distance below high-water mark.]

DATE — 1897.	Feet.	DATE — 1897.	Feet.
Jan. 1,	2.17	July 1,	1.17
Feb. 1,	1.65	Aug. 1,	1.58
March 1,	1.22	Sept. 1,	1.49
April 1,	0.67	Oct. 1,	2.22
May 1,	0.39	Nov. 1,	2.86
June 1,	0.51	Dec. 1,	1.78

FALMOUTH.

The advice of the State Board of Health to John S. Bleakie and others, relative to a proposed water supply for the villages of Falmouth and Wood's Hole, may be found on pages 11 and 12 of this volume. The results of analyses of samples of water collected from Long Pond and Grew's Pond, two of the sources considered, are given in the following table: —

Chemical Examination of Water from Grew's Pond and Long Pond, Falmouth.

[Parts per 100,000.]

Number.	Date of Collection.	Appearance.			Residue on Evaporation.		Ammonia.				Chlorine.	Nitrogen as		Oxygen Consumed.	Hardness.
		Turbidity.	Sediment.	Color.	Total.	Loss on Ignition.	Free.	Albuminoid. Total.	Albuminoid. Dissolved.	Albuminoid. Suspended.		Nitrates.	Nitrites.		
	1897.														
21227	Nov. 11	Slight.	Cons.	.10	3.35	1.30	.0116	.1204	.0260	.0944	0.84	.0090	.0002	.08	1.0
21245	Nov. 15	V. slight.	Cons.	.09	3.25	1.40	.0044	.0360	.0326	.0034	0.89	.0020	.0000	.15	1.0
21246	Nov. 15	V. slight.	V. slight.	.08	3.45	1.60	.0062	.0410	.0396	.0014	0.96	.0020	.0000	.26	1.0
21243	Nov. 15	None.	Slight.	.09	2.95	1.10	.0012	.0134	.0122	.0012	1.01	.0020	.0000	.08	1.0
21244	Nov. 15	V. slight.	Slight.	.01	3.45	1.10	.0018	.0176	.0172	.0004	0.96	.0020	.0000	.11	1.1

Odor, none, becoming sometimes faintly vegetable on heating. —— The first three samples were collected from Grew's Pond, as follows: No. 21227, from the west side; No. 21245, from the north-east side; No 21246, from the south-west side. The last two samples were collected from Long Pond, as follows: No. 21243, from the west side; No. 21244, from the south-west side.

FALMOUTH.

Microscopical Examination of Water from Grew's Pond and Long Pond, Falmouth.

[Number of organisms per cubic centimeter.]

	1897.				
	Nov.	Nov.	Nov	Nov.	Nov.
Day of examination,	12	17	17	17	17
Number of sample,	21227	21245	21246	21243	21244
PLANTS.					
Diatomaceæ,	4	0	5	12	14
Cyanophyceæ,	3,096	6	7	7	8
Anabæna,	3,096	6	7	0	0
Algæ,	0	0	4	30	22
ANIMALS.					
Rhizopoda, Actinophrys,	0	1	1	0	0
Infusoria,	184	29	75	6	0
Dinobryon,	36	29	74	3	0
Vorticella,	144	0	0	0	0
Miscellaneous, Zoöglœa,	0	3	0	0	0
TOTAL,	3,284	39	92	55	44

Water Supply of Fitchburg.

Chemical Examination of Water from Scott Reservoir, Fitchburg.

[Parts per 100,000.]

Number.	Date of Collection.	Appearance.			Residue on Evaporation.		Ammonia.				Chlorine.	Nitrogen as		Oxygen Consumed.	Hardness.
		Turbidity.	Sediment.	Color.	Total.	Loss on Ignition.	Free.	Albuminoid. Total.	Albuminoid. Dissolved.	Albuminoid. Suspended.		Nitrates.	Nitrites.		
	1897.														
18539	Feb. 17	Slight.	Slight.	.20	2.55	1.25	.0022	.0210	.0160	.0050	.28	.0030	.0000	.34	0.6
19283	May 18	Slight.	Cons.	.12	1.50	0.45	.0020	.0168	.0114	.0054	.14	.0030	.0000	.18	0.2
20286	Aug. 25	Slight.	V. slight.	.17	2.65	1.20	.0008	.0232	.0170	.0062	.13	.0050	.0000	.37	0.6
21299	Nov. 18	Slight.	Decided.	.20	2.35	1.15	.0004	.0196	.0150	.0046	.18	.0020	.0000	.30	0.5
Av...	....	....	....	.17	2.26	1.01	.0013	.0201	.0148	.0053	.18	.0032	.0000	.29	0.5

Odor, vegetable, becoming stronger and sometimes fishy or mouldy on heating. —— The samples were collected from the reservoir.

FITCHBURG.

Microscopical Examination of Water from Scott Reservoir, Fitchburg.

[Number of organisms per cubic centimeter.]

	1897.			
	February.	May.	August.	November.
Day of examination,	20	20	27	19
Number of sample,	18539	19283	20286	21299
PLANTS.				
Diatomaceæ,	0	463	902	606
Asterionella,	0	6	860	56
Melosira,	0	316	10	0
Synedra,	0	52	4	132
Tabellaria,	0	88	28	408
Algæ,	0	2	2	152
Conferva,	0	1	0	100
ANIMALS.				
Rhizopoda, Actinophrys,	0	0	2	2
Infusoria,	72	7,555	86	20
Dinobryon,	13	7,552	0	16
Peridinium,	56	3	80	2
Synura,	2	0	0	0
Vermes,	4	1	0	8
Miscellaneous, Zoöglœa,	80	40	20	5
TOTAL,	156	8,061	1,012	793

Chemical Examination of Water from Meeting-house Pond, Westminster.

[Parts per 100,000.]

Number.	Date of Collection.	Appearance.			Residue on Evaporation.		Ammonia.				Chlorine.	Nitrogen as		Oxygen Consumed.	Hardness.
		Turbidity.	Sediment.	Color.	Total.	Loss on Ignition.	Free.	Albuminoid. Total.	Albuminoid. Dissolved.	Albuminoid. Suspended.		Nitrates.	Nitrites.		
	1897.														
18538	Feb. 17	Slight.	Slight.	.07	2.90	1.35	.0036	.0264	.0158	.0106	.27	.0050	.0000	.26	1.1
18815	Mar. 18	Slight.	Cons.	.07	2.35	1.00	.0018	.0132	.0124	.0008	.19	.0030	.0000	.26	0.6
19282	May 18	V slight.	Slight.	.12	2.10	0.70	.0022	.0158	.0128	.0030	.18	.0000	.0000	.23	0.5
20287	Aug. 25	V. slight.	V. slight.	.09	2.50	1.10	.0010	.0194	.0164	.0030	.17	.0030	.0000	.31	0.9
21298	Nov. 18	V. slight.	V. slight.	.12	2.40	0.90	.0008	.0146	.0136	.0010	.20	.0020	.0000	.24	1.4

Averages by Years.

–	1893	–	–	.07	2.37	0.88	.0009	.0137	.0113	.0024	.17	.0023	.0000	.23	0.6
–	1894	–	–	.07	2.38	0.86	.0011	.0149	.0125	.0024	.18	.0026	.0000	.22	0.6
–	1895	–	–	.10	2.61	0.92	.0012	.0144	.0130	.0014	.20	.0027	.0000	.33	0.8
–	1896	–	–	.12	2.49	1.00	.0013	.0154	.0136	.0018	.19	.0049	.0000	.25	0.6
–	1897	–	–	.09	2.45	1.01	.0019	.0179	.0142	.0037	.20	.0026	.0000	.26	0.9

NOTE to analyses of 1897: Odor of the first sample, distinctly vegetable, becoming distinctly fishy on heating; of the second, distinctly fishy; of the third and fourth, distinctly vegetable; of the last, none, becoming faintly vegetable on heating. —— The samples were collected from the pond, at the gate-house.

Microscopical Examination.

An insignificant number of organisms was found in each of these samples except the first, in which 4,992 *Dinobryon* were found.

FOXBOROUGH.

Water Supply of Foxborough Water Supply District, Foxborough.

Chemical Examination of Water from the Tubular Wells of the Foxborough Water Supply District.

[Parts per 100,000.]

Number.	Date of Collection.	Appearance.			Residue on Evaporation.	Ammonia.		Chlorine.	Nitrogen as		Oxygen Consumed.	Hardness.	Iron.
		Turbidity.	Sediment.	Color.		Free.	Albuminoid.		Nitrates.	Nitrites.			
	1897.												
19819	July 19	None.	None.	.00	3.60	.0000	.0000	.30	.0470	.0000	.00	1.0	.0000

Odor, none. —— The sample was collected from a faucet at the pumping station, while pumping.

Water Supply of Framingham. — Framingham Water Company.

Chemical Examination of Water from the Filter-gallery of the Framingham Water Company

[Parts per 100,000.]

Number.	Date of Collection.	Appearance.			Residue on Evaporation.	Ammonia.		Chlorine.	Nitrogen as		Oxygen Consumed.	Hardness.	Iron.
		Turbidity.	Sediment.	Color.		Free.	Albuminoid.		Nitrates.	Nitrites.			
	1897.												
18492	Feb. 15	None.	V. slight.	.03	7.20	.0026	.0104	1.01	.0280	.0001	.06	3.1	.0120
19191	May 10	None.	None.	.00	6.20	.0020	.0054	0.98	.0250	.0000	.06	3.1	.0040
20025	Aug. 9	None.	None.	.08	7.10	.0004	.0052	0.99	.0100	.0001	.07	3.0	.0020
21060	Nov. 8	V. slight.	V. slight.	.06	7.50	.0034	.0094	1.02	.0350	.0003	.06	4.0	.0110

Averages by Years.

-	1888	-	-	.10	5.81	.0027	.0081	0.44	.0308	.0004	-	-	-
-	1889	-	-	.00	6.18	.0031	.0050	0.56	.0366	.0002	-	-	-
-	1890	-	-	.00	7.09	.0020	.0039	0.65	.0631	.0001	-	3.0	-
-	1891	-	-	.00	6.25	.0023	.0035	0.63	.0707	.0001	-	2.8	-
-	1893	-	-	.04	6.07	.0026	.0033	0.62	.0460	.0001	.11	2.6	.0099
-	1894	-	-	.03	6.75	.0025	.0043	0.79	.0515	.0001	.08	2.8	.0272
-	1895	-	-	.04	7.32	.0020	.0049	0.92	.0230	.0000	.07	3.0	.0130
-	1896	-	-	.04	7.37	.0022	.0040	0.91	.0317	.0002	.04	3.2	.0145
-	1897	-	-	.04	7.00	.0021	.0076	1.00	.0245	.0001	.06	3.3	.0072

Note to analyses of 1897: Odor, none. —— The samples were collected from the filter-gallery.

FRAMINGHAM.

Chemical Examination of Water from a Faucet in South Framingham, supplied from the Works of the Framingham Water Company.

[Parts per 100,000.]

Number.	Date of Collection.	Appearance. Turbidity.	Appearance. Sediment.	Appearance. Color.	Residue on Evaporation.	Ammonia. Free.	Ammonia. Albuminoid.	Chlorine.	Nitrogen as Nitrates.	Nitrogen as Nitrites.	Oxygen Consumed.	Hardness.	Iron.
	1897.												
18493	Feb. 15	None.	None.	0.02	6.80	.0002	.0036	0.96	.0320	.0000	.03	3.1	.0100
19192	May 10	Distinct.	Slight.	0.65	5.90	.0076	.0036	0.96	.0130	.0000	.05	3.0	.1400
20026	Aug. 9	Distinct.	Cons., rusty.	1.20	6.70	.0110	.0046	1.47	.0000	.0000	.08	2.9	.2200
21061	Nov. 8	Decided.	V. slight.	0.39	7.00	.0016	.0076	1.10	.0080	.0005	.04	4.2	.0380

Averages by Years.

Number.	Date of Collection.	Turbidity.	Sediment.	Color.	Residue on Evaporation.	Free.	Albuminoid.	Chlorine.	Nitrates.	Nitrites.	Oxygen Consumed.	Hardness.	Iron.
-	1893	-	-	0.03	5.96	.0036	.0038	0.58	.0297	.0001	.09	2.7	.0272
-	1894	-	-	0.03	6.48	.0003	.0032	0.78	.0263	.0003	.06	2.9	.0322
-	1895	-	-	0.25	6.95	.0003	.0033	0.90	.0050	.0000	.06	3.0	.0692
-	1896	-	-	0.24	7.62	.0010	.0039	0.90	.0240	.0002	.04	3.2	.0830
-	1897	-	-	0.56	6.60	.0051	.0048	1.12	.0132	.0001	.05	3.3	.1020

NOTE to analyses of 1897: Odor of the last sample, faintly earthy; of the others, none.

Chemical Examination of Water from the Underdrain beneath the Sewers at Framingham.

[Parts per 100,000.]

Number.	Date of Collection.	Appearance. Turbidity.	Appearance. Sediment.	Appearance. Color.	Residue on Evaporation.	Ammonia. Free.	Ammonia. Albuminoid.	Chlorine.	Nitrogen as Nitrates.	Nitrogen as Nitrites.	Oxygen Consumed.	Hardness.	Iron.
	1897.												
18312	Jan. 20	None.	V. slight.	.02	18.40	.0008	.0044	1.98	.4250	.0000	.04	6.0	.0020
18484	Feb. 10	None.	Slight, sandy.	.45	12.60	.0048	.0122	1.54	.2500	.0000	.30	4.7	.0100
18754	Mar. 10	V slight.	Cons.	.70	9.30	.0040	.0168	1.02	.1900	.0001	.63	3.1	.0050
19040	April 14	V. slight, milky.	Slight	.05	18.60	.0344	.0032	2.10	.4000	.0020	.07	7.3	.0330
19239	May 12	None.	V. slight.	.00	19.50	.0640	.0108	2.14	.3750	.0025	.08	7.7	.0120
19430	June 9	None.	V. slight.	.05	16.20	.0038	.0058	1.60	.3100	.0000	.08	6.4	.0030
19798	July 14	Slight.	Slight.	.38	13.30	.0168	.0122	1.35	.1375	.0035	.37	5.1	.0250
20073	Aug. 11	Slight.	Slight.	.13	20.20	.0408	.0146	2.00	.4000	.0043	.11	8.4	.0240
20497	Sept. 15	None.	V. slight.	.01	17.90	.0006	.0020	1.90	.3500	.0001	.04	5.6	.0020
20778	Oct. 13	None.	V. slight.	.00	17.30	.0006	.0092	1.72	.1500	.0000	.10	7.3	.0000
21109	Nov. 10	V. slight.	V. slight.	.08	19.80	.0376	.0092	1.95	.4650	.0022	.07	9.7	.0080
21577	Dec. 15	Decided.	Cons.	.11	17.50	.0540	.0205	1.70	.3500	.0001	.17	9.1	.0350

Averages by Years.

Number.	Date of Collection.	Turbidity.	Sediment.	Color.	Residue on Evaporation.	Free.	Albuminoid.	Chlorine.	Nitrates.	Nitrites.	Oxygen Consumed.	Hardness.	Iron.
-	1890	-	-	.01	19.71	.0823	.0073	3.51	.5336	.0026	-	8 4	-
-	1891	-	-	.01	20.44	.1029	.0045	3.51	.5333	.0019	-	8.0	-
-	1892	-	-	.01	19.32	.0805	.0042	3.99	.6667	.0018	-	8.0	-
-	1893	-	-	.02	20.75	.0829	.0039	3.84	.6282	.0014	.06	7.4	-
-	1894	-	-	.00	22.24	.0620	.0033	3.61	.5315	.0028	.08	7.1	-
-	1895	-	-	.03	20.92	.0502	.0086	2.29	.4995	.0023	.09	7.7	.0366
-	1896	-	-	.09	19.99	.0462	.0200	2.07	.3575	.0048	.17	7.2	.0419
-	1897	-	-	.16	16.72	.0218	.0101	1.75	.3169	.0012	.17	6.7	.0132

NOTE to analyses of 1897: Odor, frequently mouldy or musty, occasionally unpleasant, often none. —— The samples were collected from the underdrain, at its outlet.

FRANKLIN.

Water Supply of Franklin. — Franklin Water Company.

Chemical Examination of Water from the Wells of the Franklin Water Company

[Parts per 100,000.]

Number.	Date of Collection.	Appearance.			Residue on Evaporation.	Ammonia.		Chlorine.	Nitrogen as		Oxygen Consumed.	Hardness.	Iron.
		Turbidity.	Sediment.	Color.		Free.	Albuminoid.		Nitrates.	Nitrites.			
	1897.												
18736	Mar. 8	Slight.	Slight.	.53	3.35	.0004	.0146	.32	.0180	.0000	.48	1.3	-
19555	June 21	None.	None.	.40	6.20	.0000	.0098	.59	.0800	.0000	.42	2.2	.0050
20636	Sept. 27	V. slight.	V. slight.	.42	6.20	.0006	.0138	.63	.0000	.0000	.43	2.3	-
21517	Dec. 13	V. slight.	V. slight.	.68	5.95	.0028	.0182	.60	.0880	.0002	.55	2.5	-
Av...	....	....	....	.51	5.42	.0009	.0141	.53	.0465	.0000	.47	2.1	-

Odor, faintly vegetable, becoming somewhat stronger on heating. —— The samples were collected from a faucet in the pumping station, while pumping.

Water Supply of Gardner. — Gardner Water Company.

The organism *Uroglena* appeared in the water in the distributing reservoir of the Gardner Water Company in the early spring of 1897, imparting to it a disagreeable taste and odor.

Chemical Examination of Water from Crystal Lake, Gardner.

[Parts per 100,000.]

Number.	Date of Collection.	Appearance.			Residue on Evaporation.		Ammonia.				Chlorine.	Nitrogen as		Oxygen Consumed.	Hardness.
								Albuminoid.							
		Turbidity.	Sediment.	Color.	Total.	Loss on Ignition.	Free.	Total.	Dissolved.	Suspended.		Nitrates.	Nitrites.		
	1897.														
18442	Feb. 8	V. slight.	V. slight.	.07	3.00	0.90	.0006	.0148	.0130	.0018	.38	.0100	.0000	.10	1.1
18778	Mar. 15	V. slight.	V. slight.	.18	3.50	1.10	.0012	.0160	.0148	.0012	.44	.0080	.0000	.30	0.8
18780	Mar. 15	V. slight.	V. slight.	.35	3.25	1.00	.0000	.0114	.0104	.0010	.40	.0120	.0000	.14	0.6
19201	May 10	V. slight.	Slight.	.07	3.10	0.85	.0018	.0216	.0140	.0076	.34	.0180	.0001	.16	1.1
20107	Aug. 16	Slight.	V. slight.	.12	3.70	1.25	.0008	.0210	.0162	.0048	.36	.0050	.0000	.27	1.0
21241	Nov. 15	V. slight.	V. slight.	.09	3.40	1.15	.0014	.0172	.0168	.0004	.42	.0050	.0000	.19	1.3

Averages by Years.

-	1893	-	-	.05	2.65	0.82	.0012	.0126	.0105	.0021	.27	.0021	.0000	.19	0.8
-	1894	-	-	.04	2.75	0.98	.0009	.0111	.0094	.0017	.31	.0023	.0000	.15	1.0
-	1895	-	-	.05	2.75	0.97	.0008	.0192	.0170	.0022	.34	.0020	.0000	.17	1.2
-	1896	-	-	.06	3.07	0.94	.0020	.0156	.0120	.0036	.33	.0050	.0000	.18	1.1
-	1897*	-	-	.12	3.31	1.04	.0010	.0176	.0145	.0031	.38	.0096	.0000	.19	1.0

* Where more than one sample was collected in a month, the mean analysis for that month has been used in making the average.

Note to analyses of 1897: Odor of the last two samples, faintly earthy; of the others, distinctly vegetable, and sometimes fishy and oily. —— No. 18778 was collected from the lake; the others, from faucets in the town.

GARDNER.

Microscopical Examination of Water from Crystal Lake, Gardner.

[Number of organisms per cubic centimeter.]

	1897.					
	Feb.	Mar.	Mar.	May.	Aug.	Nov.
Day of examination,	9	16	17	11	17	16
Number of sample,	18442	18778	18780	19201	20107	21241
PLANTS.						
Diatomaceæ,	**56**	**1**	**1**	**676**	**16**	**11**
Asterionella,	0	0	0	364	4	0
Cyclotella,	56	1	0	24	1	11
Synedra,	0	0	1	288	11	0
Algæ,	**2**	**0**	**0**	**0**	**354**	**11**
Protococcus,	2	0	0	0	348	11
ANIMALS.						
Infusoria,	**188**	**612**	**504**	**531**	**1**	**0**
Dinobryon,	188	612	504	492	0	0
Peridinium,	0	0	0	38	0	0
Vermes,	**0**	**0**	**0**	**2**	**2**	**0**
Miscellaneous, Zoöglœa,	**0**	**0**	**0**	**35**	**15**	**3**
TOTAL,	246	613	505	1,244	388	25

Chemical Examination of Water from the Distributing Reservoir of the Gardner Water Company.

[Parts per 100,000.]

Number.	Date of Collection.	Appearance.			Residue on Evaporation.		Ammonia.				Chlorine.	Nitrogen as		Oxygen Consumed.	Hardness.
								Albuminoid.							
		Turbidity.	Sediment.	Color.	Total.	Loss on Ignition.	Free.	Total.	Dissolved.	Suspended.		Nitrates.	Nitrites.		
18779	1897. Mar. 15	Distinct.	Slight.	.07	3.40	1.00	.0006	.0234	.0200	.0034	.40	.0080	.0000	.21	0.8

Odor, distinctly fishy and oily. —— The sample was collected from the reservoir.

Microscopical Examination.

Infusoria, *Dinobryon*, 924; *Uroglena*, 35. Total, 959.

GEORGETOWN.

GEORGETOWN.

The advice of the State Board of Health to the town of Georgetown, relative to a proposed water supply for that town, may be found on pages 12 and 13 of this volume. During the investigation analyses were made of samples of water from several available sources, and the examinations of the water of one of the sources, Bald Pate Pond, in Boxford, were continued throughout the year. The results of these examinations are given in the following tables : —

Chemical Examination of Water from Bald Pate Pond, Boxford.

[Parts per 100,000.]

Number.	Date of Collection.	Appearance.			Residue on Evaporation.		Ammonia.				Chlorine.	Nitrogen as		Oxygen Consumed.	Hardness.
		Turbidity.	Sediment.	Color.	Total.	Loss on Ignition.	Free.	Albuminoid. Total.	Albuminoid. Dissolved.	Albuminoid. Sus-pended.		Nitrates.	Nitrites.		
	1897.														
19250	May 14	V. slight.	V. slight.	.30	3.90	1.10	.0016	.0182	.0160	.0022	.41	.0000	.0000	.34	1.4
19506	June 18	V. slight.	V. slight.	.29	3.30	0.95	.0004	.0162	.0134	.0028	.29	.0030	.0000	.43	1.4
19758	July 10	Slight.	Slight.	.31	3.85	1.55	.0002	.0186	.0126	.0060	.35	.0000	.0000	.49	1.1
19812	July 16	V. slight.	V. slight.	.30	3.60	1.45	.0022	.0234	.0206	.0028	.33	.0000	.0000	.53	1 6
20015	Aug. 6	V. slight.	V slight.	.18	3.90	1.50	.0006	.0172	.0128	.0044	.38	.0000	.0000	.43	1.4
20556	Sept. 17	Slight.	Slight.	.28	3.95	1.50	.0016	.0218	.0198	.0020	.45	.0030	.0000	.39	1.8
20955	Oct. 25	V. slight.	V. slight.	.30	3.80	1.50	.0006	.0172	.0162	.0010	.45	.0050	.0000	.31	2.3
21341	Nov. 23	V. slight.	Slight	.19	4.00	1.55	.0030	.0272	.0262	.0010	.42	.0020	.0000	.36	2.0
21675	Dec. 27	V. slight.	V. slight.	.40	4.45	1.70	.0026	.0392	.0380	.0012	.53	.0030	.0000	.41	2.0
Av.*.	....	....	....	.28	3.88	1.41	.0014	.0223	.0199	.0024	.41	.0020	.0000	.40	1.7

* Where more than one sample was collected in a month, the mean analysis for that month has been used in making the average.

Odor of No. 21341, none, becoming distinctly vegetable on heating; of No. 21675, none, becoming faintly musty on heating; of the others, distinctly vegetable. —— The samples were collected from the pond or its outlet.

Microscopical Examination of Water from Bald Pate Pond, Boxford.

[Number of organisms per cubic centimeter.]

	1897.								
	May.	June.	July.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
Day of examination,	15	19	10	19	9	18	27	24	28
Number of sample,	19250	19506	19758	19812	20015	20556	20955	21341	21675
PLANTS.									
Diatomaceæ,	167	1,002	162	106	20	1	96	670	172
Asterionella,	0	8	0	0	6	0	20	500	172
Cyclotella,	64	472	46	4	4	1	4	18	0
Fragilaria,	0	0	4	0	0	0	0	68	0
Synedra,	3	141	39	22	0	0	14	2	0
Tabellaria,	100	372	70	80	10	0	26	66	0

GEORGETOWN.

Microscopical Examination of Water from Bald Pate Pond, Boxford — Concluded.

[Number of organisms per cubic centimeter.]

	1897.								
	May.	June.	July.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
PLANTS — Con.									
Cyanophyceæ,	8	3	34	20	20	0	4	0	0
Anabæna,	8	0	0	0	10	0	0	0	0
Merismopœdia,	0	0	10	0	0	0	0	0	0
Microcystis,	0	3	24	20	10	0	4	0	0
Algæ,	0	1	22	18	88	5	4	0	0
Staurogenia,	0	0	0	6	34	0	0	0	0
ANIMALS.									
Rhizopoda,	0	0	1	0	0	0	2	0	0
Infusoria,	13	6	0	4	8	1	22	2	0
Dinobryon,	12	5	0	0	4	0	4	0	0
Trachelomonas,	0	0	0	0	4	0	10	0	0
Vermes, Anurea,	0	0	0	1	0	0	0	0	0
Crustacea, Cyclops,	0	0	0	0	0	0	pr.	pr.	0
Miscellaneous, Zoöglœa,	0	10	50	0	8	5	5	0	0
TOTAL,	188	1,022	269	149	144	12	133	672	172

Chemical Examination of Water from Rock Pond, Georgetown.

[Parts per 100,000.]

Number.	Date of Collection.	Appearance.			Residue on Evaporation.		Ammonia.				Chlorine.	Nitrogen as		Oxygen Consumed.	Hardness.
		Turbidity.	Sediment.	Color.	Total.	Loss on Ignition.	Free.	Albuminoid. Total.	Albuminoid. Dissolved.	Albuminoid. Sus-pended.		Nitrates.	Nitrites.		
	1897.														
19248	May 14	V. slight.	V. slight.	0.90	4.35	1.70	.0028	.0290	.0258	.0032	.39	.0030	.0000	1.02	1.6
19505	June 18	Slight.	V. slight	1.10	4.80	2.00	.0008	.0272	.0262	.0010	.23	.0000	.0000	1.06	1.4
19814	July 16	V. slight.	V. slight.	1.06	4.95	2.30	.0020	.0306	.0268	.0038	.28	.0020	.0000	1.01	2.0
20014	Aug. 6	V. slight	V. slight.	0.70	5.20	2.30	.0012	.0326	.0280	.0046	.34	.0000	.0000	0.89	1.8
Av.	....	....	....	0.94	4.82	2.07	.0017	.0298	.0267	.0031	.31	.0012	.0000	0.99	1.7

Odor, distinctly vegetable. —— The samples were collected from the pond, near its south-easterly end.

GEORGETOWN.

Microscopical Examination of Water from Rock Pond, Georgetown.

[Number of organisms per cubic centimeter.]

	1897.			
	May.	June.	July.	August.
Day of examination,	15	19	19	9
Number of sample,	19248	19505	19814	20014
PLANTS.				
Diatomaceæ,	13	13	78	48
Asterionella,	0	0	74	12
Cyanophyceæ,	0	5	25	8
Microcystis,	0	1	24	4
Algæ,	0	10	2	64
ANIMALS.				
Rhizopoda, Actinophrys,	0	0	0	2
Infusoria,	0	60	54	9
Dinobryon,	0	60	52	7
Vermes,	0	1	0	2
Crustacea,	0	0	pr.	0
Miscellaneous, Zoöglœa,	0	80	30	15
TOTAL,	13	169	189	148

Chemical Examination of Water from Pentucket Pond, Georgetown.

[Parts per 100,000]

Number.	Date of Collection.	Appearance.			Residue on Evaporation.		Ammonia.				Chlorine.	Nitrogen as		Oxygen Consumed.	Hardness.
								Albuminoid.							
		Turbidity.	Sediment.	Color.	Total.	Loss on Ignition.	Free.	Total.	Dissolved.	Sus-pended.		Nitrates.	Nitrites.		
	1897.														
19249	May 14	V. slight.	V. slight.	.60	4.00	1.45	.0028	.0226	.0208	.0018	.39	.0030	.0000	.62	1.6
19500	June 18	V. slight.	Slight.	.98	4.65	2.20	.0020	.0250	.0222	.0028	.22	.0020	.0000	.88	1.3
19813	July 16	V. slight.	V. slight.	.98	4.40	1.95	.0032	.0316	.0286	.0030	.26	.0030	.0000	.92	2.0
20013	Aug. 6	V. slight	V. slight.	.60	4.60	2.15	.0012	.0248	.0232	.0016	.30	.0000	.0000	.71	1.8
Av...	....	....	....	.79	4.41	1.94	.0023	.0260	.0237	.0023	.29	.0020	.0000	.78	1.7

Odor, distinctly vegetable. —— The samples were collected from the pond, about 500 feet above its outlet.

GEORGETOWN.

Microscopical Examination of Water from Pentucket Pond, Georgetown.

[Number of organisms per cubic centimeter.]

	1897.			
	May.	June.	July.	August.
Day of examination,	15	19	19	9
Number of sample,	19249	19500	19813	20013
PLANTS.				
Diatomaceæ,	68	5	192	23
Asterionella,	67	0	192	0
Cyanophyceæ,	0	0	6	10
Algæ,	1	0	18	83
ANIMALS.				
Infusoria,	7	1	4	15
Dinobryon,	0	0	3	13
Vermes, Anurea,	0	0	2	1
Crustacea,	pr.	0	pr.	0
Miscellaneous, Zoöglœa,	5	0	20	10
TOTAL,	81	6	242	142

Chemical Examination of Water from Parker River in Georgetown.

[Parts per 100,000.]

Number.	Date of Collection.	Appearance.			Residue on Evaporation.		Ammonia.				Chlorine.	Nitrogen as		Oxygen Consumed.	Hardness.
								Albuminoid.							
		Turbidity.	Sediment.	Color.	Total.	Loss on Ignition.	Free.	Total.	Dissolved.	Sus-pended.		Nitrates.	Nitrites.		
	1897.														
19251	May 14	V. slight.	Slight.	1.50	5.55	2.65	.0016	.0370	.0290	.0080	.29	.0000	.0000	1.26	1.9
19501	June 18	V. slight.	Slight.	1.35	5.45	2.60	.0012	.0306	.0290	.0016	.24	.0020	.0000	1.26	1.4
20012	Aug. 6	None.	V. slight.	1.04	6.15	2.50	.0006	.0270	.0254	.0016	.37	.0000	.0000	1.04	2.1
Av.	....	....	....	1.30	5.72	2.58	.0011	.0315	.0278	.0037	.30	.0007	.0000	1.19	1.8

Odor, distinctly vegetable. —— The samples were collected from the river, at the road crossing just above Rock Pond.

GLOUCESTER.

WATER SUPPLY OF GLOUCESTER.

The advice of the State Board of Health to the board of health of Gloucester, relative to the quality of water supplied to the city from the public water works, may be found on pages 13 to 15 of this volume.

Chemical Examination of Water from Dike's Brook Storage Reservoir, Gloucester.

[Parts per 100,000.]

Number.	Date of Collection.	Appearance.			Residue on Evaporation.		Ammonia.				Chlorine.	Nitrogen as		Oxygen Consumed.	Hardness.
		Turbidity.	Sediment.	Color.	Total.	Loss on Ignition.	Free.	Albuminoid. Total.	Albuminoid. Dissolved.	Albuminoid. Suspended.		Nitrates.	Nitrites.		
	1897.														
18327	Jan. 20	V. slight.	V. slight.	.60	5.65	2.55	.0064	.0226	.0222	.0004	1.00	.0130	.0000	.51	0.5
18823	Mar. 22	V. slight.	V. slight.	.40	3.70	1.30	.0004	.0196	.0160	.0036	0.93	.0050	.0000	.39	0.3
19301	May 24	V slight.	V. slight.	.35	3.75	1.05	.0020	.0164	.0138	.0026	0.88	.0000	.0000	.34	0.2
19773	July 13	V. slight	V. slight.	.37	3.90	1.30	.0004	.0194	.0134	.0060	0.86	.0010	.0000	.45	0.3
20477	Sept. 14	V. slight.	V. slight.	.58	3.95	1.70	.0000	.0178	.0154	.0024	0.94	.0000	.0000	.38	0.2
21101	Nov. 9	V. slight.	Slight.	.48	4.00	1.55	.0010	.0236	.0208	.0028	0.98	.0030	.0001	.39	1.7
Av...	....	....	....	.46	4.16	1.57	.0017	.0199	.0169	.0030	0.93	.0037	.0000	.41	0.5

Odor, distinctly vegetable. —— The samples were collected from the reservoir.

Microscopical Examination of Water from Dike's Brook Storage Reservoir, Gloucester.

[Number of organisms per cubic centimeter]

	1897. Jan.	March.	May.	July.	Sept.	Nov.
Day of examination,	22	23	25	16	15	12
Number of sample,	18327	18823	19301	19773	20477	21101
PLANTS.						
Diatomaceæ,	3	0	5	3	10	178
Synedra,	3	0	2	3	6	176
Algæ,	9	3	89	0	12	0
Protococcus,	2	3	84	0	4	0
ANIMALS.						
Rhizopoda, Arcella,	0	0	1	0	0	0
Infusoria,	0	21	0	1	14	5
Euglena,	0	7	0	0	14	0
Peridinium,	0	11	0	0	0	0
Vermes,	0	0	0	0	6	0
Crustacea,	0	0	0	0	0	pr.
Miscellaneous, Zoöglœa,	0	0	5	55	3	10
TOTAL,	12	24	100	59	45	193

GLOUCESTER.

Chemical Examination of Water from Wallace Pond, Gloucester.

[Parts per 100,000.]

Number.	Date of Collection.	Appearance.			Residue on Evaporation.		Ammonia.				Chlorine.	Nitrogen as		Oxygen Consumed.	Hardness.
								Albuminoid.							
		Turbidity.	Sediment.	Color.	Total.	Loss on Ignition.	Free.	Total.	Dissolved.	Suspended.		Nitrates.	Nitrites.		
	1897.														
18328	Jan. 20	V. slight.	V. slight.	1.10	6.50	2.90	.0040	.0266	.0228	.0038	1.23	.0050	.0000	.86	0.6
18822	Mar. 22	V. slight.	V. slight.	0.65	4.60	1.80	.0000	.0278	.0172	.0106	1.27	.0020	.0000	.58	0.6
19302	May 24	V. slight.	V. slight.	0.63	4.25	1.40	.0000	.0256	.0204	.0052	1.14	.0030	.0000	.45	0.8
19772	July 13	Slight.	V. slight.	0.92	4.30	1.55	.0004	.0240	.0192	.0048	1.03	.0020	.0000	.67	0.5
20476	Sept. 14	V. slight.	V. slight.	0.63	4.55	1.90	.0000	.0282	.0242	.0040	1.12	.0000	.0000	.53	0.8
21100	Nov. 9	Slight.	Slight.	0.70	4.30	1.70	.0022	.0372	.0270	.0102	1.28	.0020	.0000	.54	0.8
Av...	....	....	....	0.77	4.75	1.87	.0011	.0282	.0218	.0064	1.18	.0023	.0000	.60	0.7

Odor, generally faintly vegetable, occasionally mouldy or unpleasant. On heating, a faintly fishy odor was developed in two of the samples. —— The samples were collected from the pond.

Microscopical Examination of Water from Wallace Pond, Gloucester.

[Number of organisms per cubic centimeter.]

	1897.				
	Jan.	Mar.	May.	Sept.	Nov.
Day of examination,	22	23	25	15	12
Number of sample,	18328	18822	19302	20476	21100
PLANTS.					
Diatomaceæ,	1	0	228	1,200	96
Asterionella,	0	0	124	24	22
Cyclotella,	0	0	0	252	2
Synedra,	1	0	104	920	72
Algæ,	5	1	98	68	44
Conferva,	0	1	76	56	0
ANIMALS.					
Infusoria,	0	204	70	18	6
Monas,	0	0	0	10	0
Peridinium,	0	204	40	0	0
Raphidomonas,	0	0	28	0	0
Vermes,	0	0	1	2	4
Miscellaneous, Zoöglœa,	0	60	120	10	20
Total,	6	265	517	1,298	170

GLOUCESTER.

Chemical Examination of Water from a Faucet in Gloucester supplied from the Gloucester Water Works.

[Parts per 100,000.]

Number.	Date of Collection.	Appearance.			Residue on Evaporation.		Ammonia.				Chlorine.	Nitrogen as		Oxygen Consumed.	Hardness.
		Turbidity.	Sediment.	Color.	Total.	Loss on Ignition.	Free.	Albuminoid. Total.	Albuminoid. Dissolved.	Albuminoid. Sus-pended		Nitrates.	Nitrites.		
18329	1897. Jan. 21	V. slight.	V. slight.	0.80	6.35	2.50	.0028	.0208	.0204	.0004	1.26	.0070	.0000	.68	0.6

Odor, distinctly vegetable.

The results of an examination of a source of water supply used by the fishing vessels in Gloucester may be found on page 15 of this volume. The results of an analysis of a sample of water collected from this source are given in the following table: —

Chemical Examination of Water from a Reservoir in East Gloucester, used for the Supply of Fishing Vessels.

[Parts per 100,000.]

Number.	Date of Collection.	Appearance.			Residue on Evaporation.		Ammonia.				Chlorine.	Nitrogen as		Oxygen Consumed.	Hardness.
		Turbidity.	Sediment.	Color.	Total.	Loss on Ignition.	Free.	Albuminoid. Total.	Albuminoid. Dissolved.	Albuminoid. Sus-pended.		Nitrates.	Nitrites.		
19348	1897. June 1	Slight.	Slight.	.40	12.05	2.85	.0252	.0276	.0244	.0032	3.23	.0700	.0020	.58	3.4

Odor, distinctly vegetable and unpleasant. —— The sample was collected from the reservoir.

WATER SUPPLY OF GRAFTON. — GRAFTON WATER COMPANY.

Chemical Examination of Water from the Filter-gallery of the Grafton Water Company.

[Parts per 100,000.]

Number.	Date of Collection.	Appearance.			Residue on Evaporation.	Ammonia.		Chlorine.	Nitrogen as		Oxygen Consumed.	Hardness.	Iron.
		Turbidity.	Sediment.	Color.		Free.	Albuminoid.		Nitrates.	Nitrites.			
19946	1897. July 28	None.	None.	.00	10.90	.0004	.0026	1.46	.2300	.0000	.03	4.0	.0010

Odor, none. —— The sample was collected from a faucet in the pumping station.

Water Supply of Greenfield.

Chemical Examination of Water from Faucets in Greenfield supplied from the Greenfield Water Works.

[Parts per 100,000.]

Number.	Date of Collection.	Appearance.			Residue on Evaporation.		Ammonia.				Chlorine.	Nitrogen as		Oxygen Consumed.	Hardness.
		Turbidity.	Sediment.	Color.	Total.	Loss on Ignition.	Free.	Albuminoid. Total.	Albuminoid. Dissolved.	Albuminoid. Suspended.		Nitrates.	Nitrites.		
	1897.														
18502	Feb. 15	None.	None.	.03	4.45	0.60	.0008	.0036	.0036	.0000	.16	.0130	.0000	.07	2.6
19454	June 14	V. slight	V. slight.	.09	4.50	0.90	.0000	.0050	.0046	.0004	.05	.0380	.0000	.15	2.7
20835	Oct. 18	None.	None.	.10	6.10	1.05	.0000	.0044	.0036	.0008	.19	.0150	.0000	.15	3.6
Av.				.07	5.02	0.85	.0003	.0043	.0039	.0004	.13	.0220	.0000	.12	3.0

Odor of the first sample, faintly vegetable; of the others, none. —— The samples were collected from faucets in the village.

Water Supply of Groton. — Groton Water Company.

Population in 1895, 2,192. The works are owned by the Groton Water Company, and water was introduced in November, 1897. The source of supply is a covered masonry well, located about 50 feet from the south-westerly shore of Baddacook Pond, in Groton. The well is 30 feet in diameter, 16 feet in depth below the surface of the ground about the well and 10 feet below the ordinary water level in Baddacook Pond. No means has been provided for drawing water for the supply of the town directly from the pond. The water is pumped from the well to the town, and to a covered distributing reservoir. The distributing reservoir is rectangular in form, 172 feet long, 70 feet wide and 13 feet deep, and is covered by a wooden roof supported by masonry piers. The service pipes used are of wrought iron.

The advice of the State Board of Health to the Groton Water Company, relative to the use of water to be taken from the ground in the vicinity of Baddacook Pond as a source of water supply for the town, may be found on pages 15 to 17 of this volume. Analyses of samples of water collected from various sources in the vicinity of the pond and from test wells sunk near the pond are given in the following tables : —

GROTON.

Chemical Examination of Water from Springs and a Brook in Shattuck Meadow, about One-quarter of a Mile West of Baddacook Pond.

[Parts per 100,000.]

Number.	Date of Collection.	Appearance.			Residue on Evaporation.		Ammonia.				Chlorine.	Nitrogen as		Oxygen Consumed.	Hardness.
		Turbidity.	Sediment.	Color.	Total.	Loss on Ignition.	Free.	Albuminoid Total.	Albuminoid Dissolved.	Albuminoid Suspended.		Nitrates.	Nitrites.		
	1897.														
18765	Mar. 13	V. slight.	V. slight.	1.15	7.15	3.05	.0008	.0214	.0198	.0016	.20	.0300	.0001	.96	2.7
18766	Mar. 13	-	-	-	-	-	-	-	-	-	.20	-	-	-	3.5
18767	Mar. 13	-	-	-	-	-	-	-	-	-	.35	-	-	-	3.2
18768	Mar. 13	-	-	-	-	-	-	-	-	-	.20	-	-	-	2.7

Odor of No. 18765, distinctly vegetable. The odor was not determined in the other samples. —— The samples were collected as follows: No. 18765, from the brook; Nos. 18766 and 18767, from springs in the southerly part of Shattuck Meadow; No. 18768, from a small tributary of Shattuck Brook, in the southerly part of the meadow.

Chemical Examination of Water from Tubular Test Wells near the Southerly End of Baddacook Pond.

[Parts per 100,000.]

Number.	Date of Collection.	Appearance.			Residue on Evaporation.	Ammonia.		Chlorine.	Nitrogen as		Oxygen Consumed.	Hardness.	Iron.
		Turbidity.	Sediment.	Color.		Free.	Albuminoid.		Nitrates.	Nitrites.			
	1897.												
18947	Apr. 2	Slight.	V. slight.	.04	3.20	.0002	.0010	.19	.0030	.0000	.02	0.9	.0100
18948	Apr. 2	Slight.	V. slight.	.04	3.20	.0002	.0008	.19	.0030	.0000	.02	0.9	.0120
19058	Apr. 15	None.	V. slight.	.00	3.10	.0000	.0012	.17	.0000	.0000	.02	0.8	.0080
19059	Apr. 15	None.	None.	.00	3.10	.0004	.0008	.18	.0000	.0000	.02	0.8	.0000
19065	Apr. 16	V. slight.	Slight, sandy.	.03	3.20	.0002	.0004	.17	.0050	.0000	.02	1.1	.0040

Odor, none. —— The wells were located at a place called the "Sandy Shore," and were from 23 to 28 feet in depth.

Halifax.

Chemical Examination of Water from Stetson's Pond, in Pembroke, and from Monponsett or Stump Pond, in Halifax.

[Parts per 100,000.]

Number.	Date of Collection.	Appearance. Turbidity.	Appearance. Sediment.	Appearance. Color.	Residue on Evaporation. Total.	Residue on Evaporation. Loss on Ignition.	Ammonia. Free.	Ammonia. Albuminoid. Total.	Ammonia. Albuminoid. Dissolved.	Ammonia. Albuminoid. Sus-pended.	Chlorine.	Nitrogen as Nitrates.	Nitrogen as Nitrites.	Oxygen Consumed.	Hardness.
	1897.														
18319	Jan. 20	None.	V. slight.	0.30	-	-	.0008	.0168	-	-	-	-	-	-	-
18318	Jan. 20	V. slight.	V. slight.	1.20	-	-	.0024	.0328	-	-	-	-	-	-	-
20298	Aug.26	V. slight.	V. slight.	1.05	4.65	2.10	.0006	.0224	.0196	.0028	.64	.0020	.0000	0.87	0.5
20297	Aug.26	V. slight.	V. slight.	1.45	5.25	2.80	.0006	.0242	.0228	.0014	.63	.0030	.0000	1.22	0.8
18316	Jan. 20	V. slight.	V. slight.	2.40	8.35	5.00	.0020	.0408	.0360	.0048	.79	.0030	.0000	4.16	1.6
20296	Aug.26	V. slight.	V. slight.	2.40	6.20	3.80	.0004	.0292	.0266	.0026	.64	.0030	.0000	2.06	0.8

Odor, distinctly vegetable; of No. 20297, also grassy. —— The samples were collected as follows: No. 18319, from Stetson's Pond, at its outlet; No. 18318, from the upper basin of Monponsett Pond, above the road which crosses between the upper and middle basins of this pond; No. 20298, at the bridge, between the middle and upper basins of the pond; No. 20297, at the narrows, between the lower or Stump Pond basin and the middle basin of Monponsett Pond; Nos. 18316 and 20296, from Stump Pond, which is the lower basin of Monponsett Pond, at its outlet.

Water Supply of Hatfield.

Chemical Examination of Water from the Reservoir of the Hatfield Water Works.

[Parts per 100,000.]

Number.	Date of Collection.	Appearance. Turbidity.	Appearance. Sediment.	Appearance. Color.	Residue on Evaporation. Total.	Residue on Evaporation. Loss on Ignition.	Ammonia. Free.	Ammonia. Albuminoid. Total.	Ammonia. Albuminoid. Dissolved.	Ammonia. Albuminoid. Sus-pended.	Chlorine.	Nitrogen as Nitrates.	Nitrogen as Nitrites.	Oxygen Consumed.	Hardness.
	1897.														
18456	Feb. 8	V. slight.	Slight.	.18	3.90	0.85	.0006	.0090	.0090	.0000	.09	.0120	.0000	.21	1.4
19035	Apr. 13	V. slight.	Cons.	.10	3.70	0.60	.0000	.0052	.0044	.0008	.12	.0030	.0000	.22	1.4
19479	June 15	None.	V. slight.	.22	3.90	0.80	.0002	.0078	.0044	.0034	.05	.0050	.0000	.25	1.4
20157	Aug. 21	None.	V. slight.	.07	4.10	0.90	.0006	.0046	.0040	.0006	.11	.0050	.0000	.13	1.7
20773	Oct. 11	V. slight.	Slight.	.05	3.95	1.20	.0006	.0088	.0044	.0044	.10	.0050	.0002	.14	2.0
21592	Dec. 16	V. slight	Slight.	.38	3.25	1.10	.0008	.0082	.0072	.0010	.12	.0040	.0000	.30	1.3
Av...	....	....	....	.17	3.80	0.91	.0005	.0073	.0056	.0017	.10	.0057	.0000	.21	1.5

Odor of No. 21592, faintly musty, becoming stronger on heating; of the others, vegetable. —— The samples were collected from the reservoir.

HAVERHILL.

WATER SUPPLY OF HAVERHILL.

Chemical Examination of Water from Crystal Lake, Haverhill.

[Parts per 100,000.]

Number.	Date of Collection.	Appearance.			Residue on Evaporation.		Ammonia.				Chlorine.	Nitrogen as		Oxygen Consumed.	Hardness.
								Albuminoid.							
		Turbidity.	Sediment.	Color.	Total.	Loss on Ignition.	Free.	Total.	Dissolved.	Sus-pended.		Nitrates.	Nitrites.		
	1897.														
18623	Feb. 24	V. slight.	V. slight.	.20	3.30	1.10	.0008	.0138	.0136	.0002	.32	.0030	.0000	.37	1.0
18860	Mar. 24	V. slight.	V. slight.	.20	3.00	0.95	.0008	.0124	.0120	.0004	.30	.0000	.0000	.28	0.9
19583	June 28	Slight.	Slight.	.32	2.65	1.50	.0012	.0194	.0160	.0034	.19	.0030	.0000	.48	0.9
20940	Oct. 25	Slight.	Cons.	.20	3.00	1.50	.0004	.0252	.0148	.0104	.36	.0030	.0000	.33	1.1

Averages by Years.

-	1893	-	-	.26	2.73	1.12	.0003	.0182	.0150	.0032	.24	.0020	.0000	.37	1.0
-	1894	-	-	.17	3.05	1.03	.0017	.0220	.0193	.0027	.27	.0007	.0000	.34	1.0
-	1895	-	-	.11	3.32	1.22	.0012	.0180	.0159	.0021	.30	.0015	.0000	.36	1.5
-	1896	-	-	.25	3.00	1.22	.0007	.0219	.0152	.0067	.27	.0050	.0000	.38	1.1
-	1897	-	-	.23	2.99	1.26	.0008	.0177	.0141	.0036	.29	.0022	.0000	.36	1.0

NOTE to analyses of 1897: Odor, distinctly vegetable. —— The samples were collected from a faucet at the office of the Haverhill Water Works. For monthly record of height of water in this lake, see table on page 185.

Microscopical Examination of Water from Crystal Lake, Haverhill.

[Number of organisms per cubic centimeter.]

	1897.			
	February.	March.	June.	October.
Day of examination,	25	26	30	26
Number of sample,	18623	18860	19583	20940
PLANTS.				
Diatomaceæ,	0	23	81	28
Cyclotella,	0	0	68	2
Algæ,	0	0	7	0
ANIMALS.				
Infusoria,	56	14	1	236
Dinobryon,	52	14	0	236
Miscellaneous, Zoöglœa,	0	0	80	20
TOTAL,	56	37	169	284

HAVERHILL.

Chemical Examination of Water from Kenoza Lake, Haverhill.

[Parts per 100,000.]

Number.	Date of Collection.	Appearance.			Residue on Evaporation.		Ammonia.				Chlorine.	Nitrogen as		Oxygen Consumed.	Hardness.
		Turbidity.	Sediment.	Color.	Total.	Loss on Ignition.	Free.	Albuminoid. Total.	Albuminoid. Dissolved.	Albuminoid. Suspended.		Nitrates.	Nitrites.		
	1897.														
18339	Jan. 25	V. slight.	V. slight.	.08	4.40	1.95	.0016	.0216	.0188	.0028	.38	.0000	.0001	.27	1.8
18624	Feb. 24	V. slight.	V. slight.	.07	4.00	1.05	.0022	.0154	.0146	.0008	.41	.0000	.0000	.28	2.5
18861	Mar. 24	Distinct, milky.	Slight.	.15	4.55	1.25	.0008	.0150	.0148	.0002	.37	.0050	.0000	.24	1.7
19133	Apr. 28	V. slight.	Slight.	.12	3.80	1.05	.0008	.0152	.0134	.0018	.39	.0000	.0000	.25	1.7
19316	May 25	V. slight.	V. slight.	.12	3.60	1.25	.0014	.0152	.0152	.0000	.38	.0030	.0001	.30	1.6
19584	June 28	V. slight.	V. slight.	.11	3.30	1.10	.0018	.0168	.0156	.0012	.37	.0030	.0000	.32	1.7
19902	July 26	V. slight.	V. slight.	.07	3.90	1.10	.0002	.0168	.0144	.0024	.43	.0030	.0000	.26	1.7
20243	Aug. 23	V. slight.	V. slight.	.08	3.65	1.15	.0014	.0192	.0156	.0036	.40	.0030	.0000	.27	1.7
20634	Sept. 27	V. slight.	V. slight.	.08	3.45	1.50	.0006	.0196	.0190	.0006	.22	.0000	.0000	.25	1.9
20939	Oct. 25	V. slight.	V. slight.	.30	3.85	1.50	.0014	.0176	.0162	.0014	.41	.0050	.0000	.22	1.8
21350	Nov. 22	V. slight.	Slight.	.11	3.80	1.20	.0018	.0210	.0202	.0008	.41	.0030	.0001	.28	2.5
21665	Dec. 27	Slight.	Slight.	.17	3.70	1.15	.0010	.0200	.0182	.0018	.44	.0020	.0000	.26	2.1

Averages by Years.

-	1888	-	-	.01	3.47	0.81	.0003	.0148	-	-	.34	.0060	.0000	-	-
-	1893	-	-	.09	3.55	1.12	.0013	.0202	.0163	.0039	.41	.0010	.0000	.26	1.6
-	1894	-	-	.06	3.40	0.73	.0015	.0148	.0132	.0016	.40	.0027	.0000	.22	1.6
-	1895	-	-	.09	3.97	1.17	.0005	.0177	.0165	.0012	.44	.0000	.0000	.25	2.0
-	1896	-	-	.10	3.86	1.19	.0011	.0162	.0142	.0020	.39	.0021	.0000	.24	1.6
-	1897	-	-	.12	3.83	1.27	.0012	.0178	.0163	.0015	.38	.0022	.0000	.27	1.9

NOTE to analyses of 1897: Odor, generally distinctly vegetable; of the last sample, also fishy.—— The samples were collected from a faucet at the pumping station. During the year 1897 a small amount of water was pumped from the Millvale Reservoir on East Meadow Brook into Kenoza Lake. For monthly record of height of water in this lake, see table on page 185.

Microscopical Examination of Water from Kenoza Lake, Haverhill.

[Number of organisms per cubic centimeter.]

	1897.											
	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Oct.	Oct.	Nov.	Dec.
Day of examination,	27	25	26	29	26	30	27	24	2	26	29	28
Number of sample,	18339	18624	18861	19133	19316	19584	19902	20243	20634	20939	21350	21665
PLANTS.												
Diatomaceæ,	441	36	11	151	142	22	12	12	172	98	576	2,608
Asterionella,	392	18	3	28	7	0	0	0	0	28	424	2,304
Cyclotella,	7	18	7	76	116	0	0	0	0	0	28	52
Tabellaria,	40	0	0	13	10	16	4	5	164	48	88	196
Cyanophyceæ, Anabæna,	0	0	0	0	0	0	3	6	0	0	0	0
Algæ,	0	2	0	2	0	20	14	38	24	8	0	0

HAVERHILL.

Microscopical Examination of Water from Kenoza Lake, Haverhill — Concluded.

[Number of organisms per cubic centimeter.]

	1897.											
	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Oct.	Oct.	Nov.	Dec.
ANIMALS.												
Infusoria,	1	0	0	13	15	10	12	1	34	24	6	2
Dinobryon,	0	0	0	13	15	10	8	0	18	0	0	0
Trachelomonas,	0	0	0	0	0	0	0	0	12	22	6	0
Vermes, Anurea,	1	0	0	0	0	0	2	1	0	0	0	2
Crustacea, Cyclops,	0	0	0	0	0	0	0	0	0	pr.	0	pr.
Miscellaneous, Zoöglœa,	5	5	0	0	0	60	0	0	15	3	3	5
TOTAL,	448	43	11	166	157	112	43	58	245	133	585	2,617

Chemical Examination of Water from Lake Saltonstall, Haverhill.

[Parts per 100,000.]

Number.	Date of Collection.	Appearance.			Residue on Evaporation.		Ammonia.				Chlorine.	Nitrogen as		Oxygen Consumed.	Hardness.
								Albuminoid.							
		Turbidity.	Sediment.	Color.	Total.	Loss on Ignition.	Free.	Total.	Dissolved.	Suspended.		Nitrates.	Nitrites.		
	1897.														
18626	Feb. 24	Slight.	V. slight.	.06	6.10	1.30	.0032	.0156	.0146	.0010	.75	0050	.0000	.19	3.0
18863	Mar. 24	Slight, milky.	V. slight.	.08	3.20	1.05	.0014	.0096	.0084	.0012	.35	.0080	.0000	.15	1.4
19581	June 28	V. slight.	V. slight.	.10	5.70	1.30	.0012	.0196	.0168	.0028	.69	.0000	.0000	.28	2.6
20941	Oct. 25	V. slight.	V. slight.	.10	6.00	1.60	.0012	.0184	.0172	.0012	.80	.0280	.0000	.24	2.7

Average by Years.

–	1893	–	–	.09	5.10	1.43	.0051	.0205	.0178	.0027	.59	.0030	.0000	.25	2.2
–	1894	–	–	.08	5.00	1.08	.0025	.0155	.0139	.0017	.67	.0023	.0000	.17	2.1
–	1895	–	–	.07	5.95	1.50	.0034	.0180	.0158	.0022	.77	.0015	.0000	.21	2.6
–	1896	–	–	.10	5.43	1.22	.0020	.0149	.0123	.0026	.71	.0057	.0000	.20	2.3
–	1897	–	–	.08	5.25	1.31	.0017	.0158	.0143	.0015	.65	.0102	.0000	.21	2.4

NOTE to analyses of 1897: Odor, vegetable. —— The samples were collected from the lake. For monthly record of height of water in this lake, see table on page 185.

HAVERHILL.

Chemical Examination of Water from Lake Pentucket, Haverhill.

[Parts per 100,000.]

Number.	Date of Collection.	Appearance. Turbidity.	Appearance. Sediment.	Appearance. Color.	Residue on Evaporation. Total.	Residue on Evaporation. Loss on Ignition.	Ammonia. Free.	Ammonia. Albuminoid. Total.	Ammonia. Albuminoid. Dissolved.	Ammonia. Albuminoid. Suspended.	Chlorine.	Nitrogen as Nitrates.	Nitrogen as Nitrites.	Oxygen Consumed.	Hardness.
	1897.														
18625	Feb. 24	V. slight.	V. slight.	.05	4.40	1.25	.0000	.0190	.0182	.0008	.49	.0000	.0000	.25	2.0
18862	Mar. 24	V. slight.	V. slight.	.08	4.45	1.35	.0012	.0212	.0182	.0030	.44	.0030	.0000	.24	1.6
19585	June 28	V. slight.	V. slight.	.11	3.35	1.15	.0008	.0216	.0178	.0038	.41	.0030	.0000	.37	1.6
20942	Oct. 25	V. slight.	V. slight.	.10	3.65	1.50	.0000	.0222	.0216	.0006	.48	.0080	.0000	.19	1.8

Averages by Years.

–	1893	–	–	.07	3.43	1.07	.0009	.0199	.0160	.0039	.37	.0000	.0000	.22	1.5
–	1894	–	–	.10	3.97	1.20	.0011	.0184	.0167	.0017	.42	.0000	.0000	.24	1.6
–	1895	–	–	.05	4.30	1.20	.0005	.0198	.0183	.0015	.49	.0015	.0000	.24	2.0
–	1896	–	–	.09	4.08	1.30	.0009	.0191	.0181	.0010	.45	.0027	.0000	.27	1.7
–	1897	–	–	.08	3.96	1.31	.0005	.0210	.0190	.0020	.45	.0035	.0000	.26	1.7

NOTE to analyses of 1897: Odor, distinctly vegetable, becoming somewhat stronger in two of the samples on heating. —— The samples were collected from the lake. For monthly record of height of water in this lake, see table on page 185.

Chemical Examination of Water from Johnson's Pond in Boxford and Groveland.

[Parts per 100,000.]

Number.	Date of Collection.	Appearance. Turbidity.	Appearance. Sediment.	Appearance. Color.	Residue on Evaporation. Total.	Residue on Evaporation. Loss on Ignition.	Ammonia. Free.	Ammonia. Albuminoid. Total.	Ammonia. Albuminoid. Dissolved.	Ammonia. Albuminoid. Suspended.	Chlorine.	Nitrogen as Nitrates.	Nitrogen as Nitrites.	Oxygen Consumed.	Hardness.
	1897.														
18276	Jan. 18	V. slight.	V. slight.	.20	7.35	1.65	.0006	.0142	.0142	.0000	.40	.0000	.0000	.26	3.6
18430	Feb. 3	None.	V. slight.	.05	4.15	1.65	.0022	.0212	.0192	.0020	.41	.0030	.0000	.35	1.7
18917	Mar. 29	V. slight.	V. slight.	.20	3.65	1.40	.0004	.0194	.0174	.0020	.44	.0020	.0000	.34	1.8
19132	Apr. 28	V. slight.	Slight.	.18	3.85	1.40	.0014	.0206	.0192	.0014	.39	.0000	.0000	.31	1.8
19315	May 25	V. slight.	V. slight.	.15	3.55	1.05	.0002	.0152	.0140	.0012	.37	.0030	.0000	.31	1.7
19579	June 28	None.	V. slight.	.23	3.70	1.25	.0028	.0242	.0220	.0022	.29	.0030	.0000	.44	1.8
19905	July 26	V. slight.	V. slight.	.23	4.30	1.20	.0000	.0182	.0134	.0048	.41	.0230	.0000	.35	2.1
20244	Aug. 23	V. slight.	V. slight.	.13	4.15	1.50	.0014	.0250	.0184	.0066	.40	.0030	.0000	.32	2.1
20635	Sept. 27	V. slight.	V. slight.	.18	4.05	1.60	.0006	.0206	.0190	.0016	.40	.0000	.0000	.31	2.1
20945	Oct. 25	V. slight.	V. slight.	.45	4.10	1.45	.0014	.0198	.0190	.0008	.47	.0150	.0000	.27	2.5
21349	Nov. 22	V. slight.	V. slight.	.17	4.15	1.20	.0018	.0238	.0236	.0002	.40	.0030	.0003	.34	2.3
21664	Dec. 27	V. slight.	V. slight.	.17	4.35	1.20	.0010	.0186	.0168	.0018	.44	.0030	.0000	.33	2.1
Av...	1897	....	....	.19	4.28	1.38	.0011	.0201	.0180	.0021	.40	.0048	.0000	.33	2.1
Av...	1896	....	....	.19	4.32	1.32	.0011	.0186	.0157	.0029	.40	.0032	.0000	.32	2.0

NOTE to analyses of 1897: Odor of No. 21349, none; of No. 21664, none, becoming distinctly musty on heating; of the others, vegetable. —— Nos. 18276, 19905, 20635 and 20945 were collected from faucets in the town, and the others from the pond. Water from this pond is used to supply that portion of Haverhill which was formerly comprised in the town of Bradford. The town of Bradford was annexed to the city of Haverhill Jan. 1, 1897.

HAVERHILL.

Chemical Examination of Water from East Meadow River at its Entrance into Millvale Reservoir, Haverhill.

[Parts per 100,000.]

Number.	Date of Collection.	Appearance.			Residue on Evaporation.		Ammonia.				Chlorine.	Nitrogen as		Oxygen Consumed.	Hardness.
								Albuminoid.							
		Turbidity.	Sediment.	Color.	Total.	Loss on Ignition.	Free.	Total.	Dissolved.	Sus-pended.		Nitrates.	Nitrites.		
	1897.														
18341	Jan 25	V. slight.	Slight.	0.70	6.25	2.65	.0030	.0234	.0130	.0104	.40	.0080	.0000	0.69	1.8
18627	Feb. 24	V. slight.	V. slight.	0.90	5.95	2.15	.0010	.0180	.0156	.0024	.35	.0070	.0000	0.69	2.3
18915	Mar 29	V. slight.	V. slight.	0.85	4 40	1.85	.0002	.0178	.0172	.0006	.31	.0070	.0000	0.72	1.4
19131	Apr. 28	None.	Slight.	1.00	5.00	2.05	.0010	.0250	.0232	.0018	.29	.0000	.0000	0.76	1.8
19314	May 25	Slight.	Cons.	1.10	5.00	2.45	.0006	.0280	.0252	.0028	.25	.0030	.0000	1.04	1.7
19580	June 28	None.	V. slight.	0.65	4.80	1.80	.0012	.0142	.0136	.0006	.21	.0050	.0000	0.61	1.8
19903	July 26	V. slight.	V. slight	1.30	6.50	3.15	.0006	.0274	.0264	.0010	.32	.0140	.0000	1.43	2.1
20241	Aug. 23	V. slight.	V. slight.	0.85	6.00	2.40	.0014	.0254	.0220	.0034	.31	.0030	.0000	0.84	2.2
20632	Sept. 27	Slight, clayey.	Slight.	0.68	5.75	2.10	.0008	.0190	.0190	.0000	.33	.0030	.0000	0.71	2.2
20944	Oct 25	V. slight.	V. slight.	0.42	5.15	1.75	.0010	.0124	.0124	.0000	.38	.0090	.0000	0.30	2.1
21351	Nov. 22	V. slight.	Cons.	1.25	6.00	2.80	.0024	.0280	.0276	.0004	.39	.0060	.0000	1.12	2.2
21666	Dec 27	V. slight.	Slight.	0.85	5.30	1.80	.0018	.0174	.0144	.0030	.36	.0070	.0000	0.62	2.1
Av..	....	....	....	0.88	5.51	2.25	.0012	.0213	.0191	.0022	.32	.0060	.0000	0.79	2.0

Odor, vegetable. —— The samples were collected from the river, at Thompson's bridge, just above its entrance into the Millvale storage reservoir.

Chemical Examination of Water from Millvale Reservoir on East Meadow River, Haverhill.

[Parts per 100,000.]

Number.	Date of Collection.	Appearance.			Residue on Evaporation.		Ammonia.				Chlorine.	Nitrogen as		Oxygen Consumed.	Hardness.
								Albuminoid.							
		Turbidity.	Sediment.	Color.	Total.	Loss on Ignition.	Free.	Total.	Dissolved.	Sus-pended.		Nitrates.	Nitrites.		
	1897.														
18340	Jan. 25	V. slight.	V. slight.	0.65	5.55	2.60	.0018	.0278	.0196	.0082	.39	.0070	.0002	0.70	1.6
18628	Feb. 24	V. slight.	V. slight.	0.80	5.40	2.05	.0008	.0138	.0138	.0000	.38	.0050	.0000	0.68	1.9
18916	Mar. 29	V. slight.	V. slight.	0.75	3.60	1.60	.0002	.0202	.0184	.0018	.27	.0070	.0000	0.70	1.4
19134	Apr. 28	V. slight.	Slight.	0.74	4.40	1.75	.0010	.0210	.0210	.0000	.27	.0000	.0001	0.65	1.6
19317	May 25	V. slight.	V. slight.	1.05	4.65	2.25	.0010	.0280	.0216	.0064	.25	.0000	.0000	0.94	1.4
19582	June 28	V. slight.	Slight.	1.26	4.55	2.45	.0006	.0244	.0208	.0036	.14	.0030	.0000	1.23	1.4
19904	July 26	V. slight.	Slight.	0.68	4.75	1.90	.0000	.0200	.0174	.0026	.28	.0030	.0000	0.74	2.0
20242	Aug 23	V. slight.	V. slight.	0.63	5.30	2.35	.0012	.0248	.0234	.0014	.26	.0000	.0000	0.75	1.8
20633	Sept. 27	V slight.	Slight.	0.52	5.15	2.35	.0006	.0236	.0220	.0016	.32	.0000	.0000	0.62	2.2
20943	Oct. 25	Slight.	Slight.	0.50	5.05	2.25	.0006	.0228	.0222	.0006	.31	.0130	.0000	0.50	1.9
21352	Nov. 22	V. slight.	Cons.	1.23	5.90	2.55	.0020	.0320	.0304	.0016	.41	.0040	.0000	1.14	2.3
21667	Dec. 27	V. slight.	V. slight.	1.24	5.55	2.65	.0008	.0244	.0220	.0024	.40	.0060	.0000	0.98	1.7
Av..	....	....	....	0.84	4.99	2.23	.0009	.0236	.0211	.0025	.31	.0040	.0000	0.80	1.8

Odor, vegetable. —— The samples were collected from the reservoir, near its outlet.

HAVERHILL.

Microscopical Examination of Water from Millvale Reservoir on East Meadow River, Haverhill.

[Number of organisms per cubic centimeter.]

	1897.											
	Jan.	Feb.	Mar.	Apr.	May.	June.	July	Aug.	Oct.	Oct.	Nov.	Dec.
Day of examination,	27	26	30	29	27	30	27	24	2	26	29	28
Number of sample,	18340	18628	18916	19134	19317	19582	19904	20242	20633	20943	21352	21667
PLANTS.												
Diatomaceæ,	0	1	26	28	75	59	24	13	74	31	68	5
Algæ,	2	0	0	0	0	3	0	0	6	0	0	0
ANIMALS.												
Infusoria,	9	0	12	51	394	129	20	0	6	27	4	0
Dinobryon,	0	0	11	49	390	125	1	0	0	26	0	0
Peridinium,	9	0	0	2	0	4	18	0	0	0	1	0
Vermes,	0	0	0	0	0	0	1	0	0	2	3	0
Miscellaneous, Zoögiœa,	30	0	0	10	45	120	55	20	120	0	8	0
TOTAL,	41	1	38	89	514	311	100	33	206	60	83	5

Table showing the Heights of Water in the Lakes of the Haverhill Water Works on the First of Each Month in 1897.

DATE.	Crystal Lake. High Water, 8.00 Feet.	Kenoza Lake. High Water, 4.00 Feet.	Lake Saltonstall. High Water, 7.83 Feet.	Lake Pentucket. High Water, 6.67 Feet.
Jan. 1,	4.67	3.67	–	–
Feb. 1,	4.44	3.83	7.67	4.08
March 1,	5.04	4.48	8.15	4.79
April 1,	6.92	4.83	8.08	5.35
May 1,	7.67	5.00	8.00	5.75
June 1,	8.37	4.92	8.25	6.58
July 1,	7.71	4.92	8.25	6.37
Aug 1,	6.50	4.73	8.21	6.08
Sept. 1,	5.75	4.37	7.98	5.42
Oct. 1,	4.67	3.92	7.83	5.17
Nov. 1,	4.21	3.42	7.67	5.00
Dec. 1,	4.69	3.50	7.83	5.17

HINGHAM.

Water Supply of Hingham and Hull. — Hingham Water Company.

The organism *Uroglena* appeared in the water of Accord Pond in December, 1897, and the taste and odor of the water became very disagreeable. The water continued to give serious trouble from this cause in the early part of 1898.

Chemical Examination of Water from Accord Pond, Hingham.

[Parts per 100,000.]

Number.	Date of Collection.	Appearance.			Residue on Evaporation.		Ammonia.				Chlorine.	Nitrogen as		Oxygen Consumed.	Hardness.
		Turbidity.	Sediment.	Color.	Total	Loss on Ignition.	Free.	Albuminoid Total.	Albuminoid Dissolved.	Albuminoid Suspended.		Nitrates.	Nitrites.		
	1897.														
18740	Mar. 9	Slight.	Slight.	.30	2.80	1.00	.0000	.0120	.0110	.0010	.72	.0070	.0000	.36	0.5
19452	June 11	None.	V. slight.	.28	2.90	0.70	.0018	.0138	.0128	.0010	.60	.0030	.0000	.43	0.5
19453	June 11	None.	V. slight.	.26	3.00	0.50	.0006	.0114	.0106	.0008	.59	.0030	.0000	.36	0.5
19598	June 28	V. slight.	V. slight.	.25	3.10	0.90	.0012	.0182	.0148	.0034	.60	.0030	.0000	.42	0.2
20420	Sept. 8	V. slight.	Slight.	.18	3.00	1.00	.0000	.0142	.0098	.0044	.70	.0020	.0000	.33	0.3
21474	Dec. 7	V. slight.	Slight.	.20	3.10	1.15	.0020	.0142	.0132	.0010	.74	.0030	.0000	.27	1.1
21685	Dec. 29	V. slight.	Slight.	.30	3.30	1.05	.0006	.0170	.0134	.0036	.74	.0020	.0000	.33	1.0
21686	Dec. 29	V. slight.	Slight.	.30	3.20	1.05	.0006	.0128	.0116	.0012	.72	.0030	.0000	.29	1.0
21687	Dec. 29	V. slight.	Cons.	.29	3.45	1.20	.0006	.0266	.0152	.0114	.74	.0040	.0000	.31	1.0

Averages by Years.

-	1888	-	-	.22	2.93	0.97	.0001	.0162	-	-	.56	.0046	.0001	-	-
-	1893	-	-	.16	3.02	1.00	.0003	.0121	.0103	.0018	.63	.0032	.0000	.29	0.3
-	1894	-	-	.20	3.04	1.11	.0002	.0114	.0097	.0017	.62	.0024	.0000	.33	0.3
-	1895	-	-	.22	3.50	1.37	.0008	.0135	.0121	.0014	.67	.0110	.0000	.31	0.3
-	1896	-	-	.22	3.02	1.22	.0007	.0150	.0132	.0018	.62	.0027	.0000	.37	0.3
-	1897*	-	-	.28	3.01	0.95	.0005	.0145	.0117	.0028	.69	.0037	.0000	.35	0.5

* Where more than one sample was collected in a month, the mean analysis for that month has been used in making the average.

Note to analyses of 1897: Odor of No. 18740, faintly vegetable, disappearing on heating; of No. 19452, distinctly mouldy and grassy; of Nos. 19453, 19598 and 20420, distinctly vegetable; of the others, distinctly fishy and oily. —— The samples were collected from the pond.

Microscopical Examination of Water from Accord Pond, Hingham.

[Number of organisms per cubic centimeter.]

	1897.								
	Mar.	June.	June.	July.	Sept.	Dec.	Dec.	Dec.	Dec.
Day of examination,	11	12	12	3	10	8	30	30	30
Number of sample,	18740	19452	19453	19598	20420	21474	21685	21686	21687
PLANTS.									
Diatomaceæ,	6	46	15	0	17	5	2	8	0
Cyanophyceæ, Anabæna,	0	30	1	0	0	0	0	0	0
Algæ, Protococcus,	0	1	0	0	22	0	0	0	0
ANIMALS.									
Rhizopoda, Difflugia,	0	0	1	0	0	0	0	0	0
Infusoria,	3	3	0	5	0	0	8	8	15
Uroglena,	0	0	0	0	0	0	7	4	14
Vermes, Polyarthra,	0	0	0	1	0	0	0	0	0
Crustacea, Cyclops,	0	0	0	0	0	pr.	0	0	0
Miscellaneous, Zoöglœa,	10	0	0	25	3	.0	0	0	0
TOTAL,	19	80	17	31	42	5	10	16	15

Chemical Examination of Water from Fulling Mill Pond, Hingham.

[Parts per 100,000.]

Number.	Date of Collection.	Appearance.			Residue on Evaporation.		Ammonia.				Chlorine.	Nitrogen as		Oxygen Consumed.	Hardness.
								Albuminoid.							
		Turbidity.	Sediment.	Color.	Total.	Loss on Ignition.	Free.	Total.	Dissolved.	Sus-pended.		Nitrates.	Nitrites.		
	1897.														
18739	Mar. 9	V. slight.	V. slight.	.05	4.70	1.45	.0006	.0028	.0024	.0004	.84	.0180	.0000	.04	1.3
19599	June 28	V. slight.	Slight.	.09	4.70	0.90	.0008	.0032	.0022	.0010	.77	.0150	.0000	.13	1.1
20421	Sept. 8	V. slight.	Slight.	.07	5.10	1.00	.0012	.0022	.0020	.0002	.76	.0130	.0000	.09	1.3
21473	Dec. 7	V. slight.	V. slight.	.16	5.10	1.20	.0018	.0052	.0044	.0008	.80	.0280	.0000	.12	1.8
Av...	....	....	....	.09	4.90	1.14	.0011	.0033	.0027	.0006	.79	.0185	.0000	.09	1.4

Odor of Nos. 18739 and 20421, faintly vegetable, disappearing on heating; of No. 19599, distinctly vegetable; of No. 21473, none. —— The samples were collected at the gate-house, and represent the water from the filter-basins at the edge of the pond.

HINGHAM.

Chemical Examination of Water from a Faucet in Hingham supplied from the Works of the Hingham Water Company.

[Parts per 100,000.]

Number.	Date of Collection.	Appearance.			Residue on Evaporation.		Ammonia.				Chlorine.	Nitrogen as		Oxygen Consumed.	Hardness.
		Turbidity.	Sediment.	Color.	Total.	Loss on Ignition.	Free.	Albuminoid. Total.	Albuminoid. Dissolved	Albuminoid. Suspended		Nitrates.	Nitrites.		
	1897.														
21688	Dec. 29	V. slight.	V. slight.	.30	3.55	1.30	.0004	.0150	.0124	.0026	.74	.0030	.0000	.30	0.8

Odor, distinctly fishy, becoming strongly fishy and oily on heating.

Water Supply of Hinsdale Fire District, Hinsdale.

Chemical Examination of Water from the Storage Reservoir of the Hinsdale Fire District.

[Parts per 100,000.]

Number.	Date of Collection.	Appearance.			Residue on Evaporation.		Ammonia.				Chlorine.	Nitrogen as		Oxygen Consumed.	Hardness.
		Turbidity.	Sediment.	Color.	Total.	Loss on Ignition.	Free.	Albuminoid. Total.	Albuminoid. Dissolved.	Albuminoid. Suspended.		Nitrates.	Nitrites.		
	1897.														
18355	Jan. 25	V. slight.	V. slight.	.30	2.75	1.30	.0008	.0296	.0154	.0142	.04	.0050	.0000	.41	0.9
18613	Feb. 22	V. slight.	V. slight.	.42	2.60	1.30	.0092	.0204	.0158	.0046	.06	.0030	.0000	.44	0.9
18854	Mar. 23	Slight.	V. slight.	.35	2.35	0.80	.0030	.0222	.0154	.0068	.07	.0020	.0000	.32	0.5
19080	Apr. 19	V. slight.	V. slight.	.40	1.95	0.70	.0008	.0168	.0166	.0002	.03	.0000	.0000	.31	0.5
19263	May 17	V. slight.	V. slight.	.25	1.75	0.50	.0006	.0174	.0108	.0066	.06	.0000	.0000	.38	0.5
19571	June 23	Slight.	Slight.	.29	2.80	1.50	.0002	.0172	.0102	.0070	.04	.0050	.0000	.31	1.0
19954	July 28	Slight.	V. slight.	.38	2.70	0.95	.0028	.0192	.0140	.0052	.05	.0030	.0004	.40	1.4
20281	Aug. 25	Slight.	V. slight.	.41	2.30	0.90	.0008	.0170	.0124	.0046	.03	.0000	.0000	.40	1.1
20669	Sept. 28	V. slight.	V. slight.	.43	2.55	1.35	.0000	.0186	.0150	.0036	.05	.0030	.0000	.39	0.8
20978	Oct. 27	V. slight.	V slight.	.58	2.35	1.30	.0006	.0164	.0154	.0010	.07	.0030	.0000	.41	1.3
21397	Nov. 29	V slight.	None.	.37	2.25	0.95	.0012	.0164	.0152	.0012	.10	.0020	.0000	.42	0.5
21679	Dec. 28	V. slight.	None.	.29	2.10	1.00	.0032	.0134	.0106	.0028	.09	.0030	.0000	.36	1.3
Av...	....	....	....	.37	2.37	1.05	.0019	.0187	.0139	.0048	.06	.0024	.0000	.38	0.9

Odor of Nos. 18854, 19080, 19263 and 19954, distinctly fishy; of Nos. 18355 and 18613, distinctly vegetable, becoming distinctly fishy on heating; of the others, distinctly vegetable. —— The samples were collected from a faucet in the village.

HINSDALE.

Microscopical Examination of Water from the Storage Reservoir of the Hinsdale Fire District.

[Number of organisms per cubic centimeter]

	1897.											
	Jan.	Feb.	Mar	Apr.	May.	June.	July.	Aug.	Oct.	Oct.	Nov.	Dec.
Day of examination,	29	25	26	22	18	25	30	27	4	28	30	29
Number of sample,	18355	18613	18854	19080	19263	19571	19954	20281	20669	20978	21397	21679
PLANTS.												
Diatomaceæ,	0	0	0	4	28	1	1	7	4	13	11	2
ANIMALS.												
Infusoria,	22	5	5	1	5	304	120	2	0	0	8	47
Peridinium,	22	2	3	1	4	304	120	2	0	0	6	47
Vermes,	1	0	1	0	0	0	2	0	0	0	0	0
Crustacea, Bosmina,	0	0	0	pr.	0	0	0	0	0	0	0	0
Miscellaneous, Zoöglœa,	0	0	30	40	60	160	60	25	60	3	0	3
TOTAL,	23	5	36	45	93	465	183	34	64	16	19	52

WATER SUPPLY OF HOLBROOK.

(See *Randolph*)

WATER SUPPLY OF HOLLISTON. — HOLLISTON WATER COMPANY.

Chemical Examination of Water from the Works of the Holliston Water Company.

[Parts per 100,000.]

Number.	Date of Collection.	Appearance.			Residue on Evaporation.	Ammonia.		Chlorine.	Nitrogen as		Oxygen Consumed.	Hardness.	Iron.
		Turbidity.	Sediment.	Color.		Free.	Albuminoid.		Nitrates.	Nitrites.			
	1897.												
18344	Jan. 25	V. slight.	None.	.23	4.20	.0012	.0088	.33	.0150	.0000	.22	1.3	.0230
18724	Mar. 9	None.	V. slight	.23	3.40	.0010	.0076	.34	.0150	.0001	.19	1.1	.0130
19212	May 11	None.	None.	.20	2.20	.0000	.0074	.32	.0180	.0000	.18	1.3	.0030
19768	July 12	V. slight.	V. slight.	.38	4.80	.0000	.0110	.27	.0030	.0000	.20	1.6	.0400
20469	Sept. 13	None.	None.	.08	4.50	.0006	.0058	.30	.0030	.0000	.13	1.7	.0140
21236	Nov. 15	Slight.	Slight.	.40	4.40	.0020	.0154	.44	.0080	.0002	.38	2.0	.0060

HOLLISTON.

Chemical Examination of Water from the Works of the Holliston Water Company — Concluded.

Averages by Years.

[Parts per 100,000.]

Number.	Date of Collection.	Appearance.			Residue on Evaporation.	Ammonia.		Chlorine.	Nitrogen as		Oxygen Consumed.	Hardness.	Iron.
		Turbidity.	Sediment.	Color.		Free.	Albuminoid.		Nitrates.	Nitrites.			
–	1892	–	–	.05	4.16	.0001	.0043	.27	.0108	.0000	–	2.1	.0430
–	1894	–	–	.10	4.60	.0001	.0035	.32	.0155	.0001	.08	2.4	.0218
–	1895	–	–	.25	4.28	.0006	.0097	.31	.0117	.0000	.29	1.6	.0095
–	1896	–	–	.28	3.68	.0003	.0114	.28	.0052	.0000	.30	1.0	.0087
–	1897	–	–	.25	3.92	.0008	.0093	.33	.0103	.0000	.22	1.5	.0015

NOTE to analyses of 1897: Odor of No. 19768, faintly vegetable; of the others, none, sometimes becoming faintly vegetable on heating. —— No. 18724 was collected from a faucet in the town; the others, from a faucet at the pumping station.

Water Supply of Holyoke.

Chemical Examination of Water from Whiting Street Storage Reservoir, Holyoke.

[Parts per 100,000.]

Number.	Date of Collection.	Appearance.			Residue on Evaporation.		Ammonia.				Chlorine.	Nitrogen as		Oxygen Consumed.	Hardness.
		Turbidity.	Sediment.	Color.	Total.	Loss on Ignition.	Free.	Albuminoid. Total.	Albuminoid. Dissolved.	Albuminoid. Suspended.		Nitrates.	Nitrites.		
	1897.														
18392	Jan. 27	V. slight.	Slight.	.15	4.90	1.90	.0000	.0284	.0198	.0086	.13	.0030	.0000	.36	2.5
18867	Mar. 24	V. slight.	Slight.	.10	4.55	1.25	.0004	.0216	.0172	.0044	.15	.0000	.0000	.20	2.9
19325	May 25	Slight.	Slight.	.20	4.50	1.40	.0014	.0264	.0150	.0114	.11	.0000	.0000	.25	2.2
19949	July 28	Slight.	Slight.	.14	4.65	1.55	.0006	.0284	.0188	.0096	.13	.0020	.0001	.38	2.7
20683	Sept. 30	Slight.	Cons.	.15	5.15	1.50	.0000	.0288	.0222	.0066	.10	.0000	.0001	.32	3.0
21357	Nov. 24	V. slight.	Slight.	.28	4.70	1.75	.0004	.0296	.0214	.0082	.10	.0020	.0000	.36	2.9
Av...	....	....	....	.17	4.74	1.56	.0005	.0272	.0191	.0081	.12	.0012	.0000	.31	2.7

Odor distinctly vegetable. —— The samples were collected from the reservoir.

HOLYOKE.

Microscopical Examination of Water from Whiting Street Reservoir, Holyoke.

[Number of organisms per cubic centimeter.]

	1897.					
	Feb.	Mar.	May.	July.	Oct.	Nov.
Day of examination,	1	26	27	30	6	29
Number of sample,	18392	18867	19325	19949	20683	21357
PLANTS.						
Diatomaceæ,	10	101	2,158	58	182	226
Asterionella,	8	80	1,620	0	60	38
Fragilaria,	0	0	0	52	62	152
Synedra,	2	8	536	4	52	34
Cyanophyceæ,	0	0	20	32	14	0
Anabæna,	0	0	20	16	6	0
Cœlosphærium,	0	0	0	16	8	0
Algæ,	148	92	527	346	126	134
Protococcus,	92	80	148	30	42	120
Raphidium,	0	0	24	68	22	12
Selenastrum,	0	0	2	212	0	0
Staurastrum,	56	12	308	0	10	0
ANIMALS.						
Infusoria,	32	88	65	12	124	16
Cryptomonas,	0	16	0	0	0	0
Dinobryon,	0	28	60	0	4	0
Euglena,	0	0	0	0	10	2
Peridinium,	32	36	0	0	0	0
Trachelomonas,	0	4	5	12	100	12
Vermes,	2	6	0	0	2	6
Crustacea,	pr.	pr.	pr.	0	pr.	pr.
Miscellaneous, Zoöglœa,	10	60	150	10	200	10
TOTAL,	202	347	2,920	458	648	392

Chemical Examination of Water from Wright and Ashley Ponds, Holyoke.

[Parts per 100,000.]

Number.	Date of Collection.	Appearance.			Residue on Evaporation.		Ammonia.				Chlorine.	Nitrogen as		Oxygen Consumed.	Hardness.
								Albuminoid.							
		Turbidity.	Sediment.	Color.	Total.	Loss on Ignition.	Free.	Total.	Dissolved.	Sus-pended.		Nitrates.	Nitrites.		
	1897.														
18391	Jan. 27	Slight.	V. slight.	.23	5.75	2.75	.0036	.0408	.0408	.0000	.26	.0050	.0000	.40	2.5
18505	Feb. 15	Slight.	Slight.	.20	5.20	1.90	.0032	.0458	.0362	.0096	.20	.0030	.0000	.36	2.9
18866	Mar. 24	V. slight.	V. slight.	.10	4.60	1.25	.0014	.0194	.0162	.0032	.14	.0030	.0000	.20	3.0
19324	May 25	V. slight.	V. slight.	.07	5.20	1.30	.0018	.0178	.0144	.0034	.16	.0000	.0000	.15	3.2
19947	July 28	V. slight.	V. slight.	.07	5.65	1.15	.0024	.0226	.0170	.0056	.14	.0000	.0000	.21	3.5
20684	Sept. 30	V. slight.	V. slight.	.08	5.65	1.05	.0010	.0182	.0148	.0034	.10	.0000	.0000	.16	3.6
21358	Nov. 24	None.	Slight.	.18	5.50	1.55	.0076	.0256	.0216	.0040	.16	.0070	.0001	.26	3.9
Av.	....	....	....	.13	5.36	1.56	.0030	.0272	.0230	.0042	.17	.0026	.0000	.25	3.2

Odor, generally vegetable, occasionally fishy. —— The samples were collected from Ashley Pond.

HOLYOKE.

Microscopical Examination of Water from Wright and Ashley Ponds, Holyoke.

[Number of organisms per cubic centimeter.]

	1897.						
	Feb.	Feb.	Mar.	May.	July.	Oct.	Nov.
Day of examination,	1	18	26	27	30	6	29
Number of sample,	18391	18505	18866	19324	19947	20684	21358
PLANTS.							
Diatomaceæ,	**32**	**0**	**52**	**372**	**56**	**33**	**40**
Asterionella,	0	0	0	116	2	19	25
Synedra,	24	0	12	66	2	5	0
Tabellaria,	0	0	22	124	52	0	3
Cyanophyceæ,	**0**	**72**	**2**	**0**	**11**	**62**	**0**
Anabæna,	0	0	0	0	11	56	0
Oscillaria,	0	72	2	0	0	0	0
Algæ,	**0**	**0**	**0**	**6**	**20**	**14**	**5**
ANIMALS.							
Rhizopoda,	**0**	**0**	**2**	**2**	**0**	**0**	**0**
Infusoria,	**6**	**64**	**67**	**0**	**2**	**0**	**13**
Dinobryon,	0	16	34	0	0	0	11
Synura,	0	40	4	0	0	0	0
Uroglena,	0	0	25	0	0	0	0
Vermes,	**0**	**0**	**0**	**2**	**0**	**0**	**0**
Crustacea, Cyclops,	**0**	**0**	**0**	pr.	**0**	**0**	**0**
Miscellaneous, Zoöglœa,	**40**	**40**	**20**	**40**	**5**	**15**	**3**
TOTAL,	78	176	143	422	94	124	61

Chemical Examination of Water from Manhan River, in Southampton.

[Parts per 100,000.]

Number.	Date of Collection.	Appearance.			Residue on Evaporation.		Ammonia.				Chlorine.	Nitrogen as		Oxygen Consumed.	Hardness.
								Albuminoid.							
		Turbidity.	Sediment.	Color.	Total.	Loss on Ignition.	Free.	Total.	Dissolved.	Sus-pended.		Nitrates.	Nitrites.		
	1897.														
18390	Jan. 27	V. slight.	Slight.	.10	3.95	1.35	.0008	.0058	.0044	.0014	.10	.0050	.0000	.49	1.1
19122	Apr. 26	V. slight.	Slight.	.30	2.45	0.85	.0006	.0092	.0080	.0012	.07	.0000	.0000	.33	0.8
19326	May 24	V. slight.	Slight.	.32	3.65	1.25	.0004	.0086	.0086	.0000	.08	.0030	.0000	.37	1.4
19565	June 22	None.	Slight.	.30	3.15	1.05	.0012	.0086	.0052	.0034	.08	.0030	.0000	.30	1.1
19948	July 27	V. slight.	V. slight.	.48	3.45	1.50	.0010	.0138	.0120	.0018	.09	.0180	.0000	.61	1.0
20269	Aug. 23	None.	Slight.	.28	3.00	1.00	.0004	.0056	.0046	.0010	.07	.0030	.0000	.33	1.6
20682	Sept. 30	V. slight.	V. slight.	.23	3.90	0.95	.0006	.0080	.0058	.0022	.12	.0020	.0000	.20	2.3
20995	Oct. 27	V. slight.	Slight.	.40	3.85	1.35	.0014	.0118	.0116	.0002	.15	.0200	.0000	.26	1.4
21356	Nov. 24	None.	V. slight.	.40	3.60	1.35	.0008	.0104	.0100	.0004	.15	.0030	.0000	.44	1.8
21718	Dec. 29	V. slight.	Slight.	.17	3.10	1.10	.0004	.0090	.0086	.0004	.16	.0070	.0000	.21	1.4
Av...	....	....	....	.30	3.41	1.17	.0008	.0091	.0079	.0012	.11	.0064	.0000	.35	1.4

Odor in November, none; in December, none, becoming faintly earthy on heating; of the others, vegetable.—— The samples were collected from the river, at the confluence of Manhan and Tucker brooks, near the site of a proposed reservoir.

Water Supply of Hopedale.

(See *Milford.*)

Water Supply of Hudson.

The advice of the State Board of Health to the town of Hudson, with reference to an additional water supply for the town, may be found on pages 17 to 21 of this volume. The results of analyses of samples of water collected from the present source and from proposed sources of additional supply are given in the following tables: —

Chemical Examination of Water from Gates Pond, Berlin.

[Parts per 100,000.]

Number.	Date of Collection.	Appearance.			Residue on Evaporation.		Ammonia.				Chlorine.	Nitrogen as		Oxygen Consumed.	Hardness.
		Turbidity.	Sediment.	Color.	Total.	Loss on Ignition.	Free.	Albuminoid. Total.	Albuminoid. Dissolved.	Albuminoid. Suspended.		Nitrates.	Nitrites.		
	1897.														
18474	Feb. 10	V. slight.	V. slight.	.05	2.45	0.95	.0304	.0170	.0158	.0012	.41	.0070	.0001	.22	0.5
18515	Feb. 16	V. slight.	V. slight.	.03	2.15	0.75	.0046	.0134	.0122	.0012	.28	.0030	.0000	.14	0.6
18964	Apr. 6	V. slight.	V. slight.	.03	2.30	0.75	.0024	.0136	.0118	.0018	.21	.0030	.0000	.14	0.6
19451	June 11	None.	V. slight.	.03	1.80	0.75	.0022	.0188	.0172	.0016	.17	.0000	.0000	.12	0.5
20043	Aug. 10	Slight.	V. slight.	.05	2.35	0.95	.0004	.0144	.0112	.0032	.20	.0020	.0000	.16	0.6
20762	Oct. 12	V. slight.	V. slight.	.05	2.45	1.20	.0010	.0144	.0116	.0028	.25	.0000	.0000	.15	0.8
21503	Dec. 13	V. slight.	Slight.	.12	2.00	1.00	.0046	.0190	.0178	.0012	.24	.0070	.0000	.13	0.8
Av.*.	....	....	....	.05	2.20	0.92	.0047	.0159	.0139	.0020	.23	.0028	.0000	.15	0.6

* Where more than one sample was collected in a month, the mean analysis for that month has been used in making the average.

Odor of the first sample, unpleasant; of the others, generally faintly vegetable, becoming somewhat stronger on heating. —— The samples were collected from the pond. For monthly record of height of water in this pond, see page 195.

Microscopical Examination of Water from Gates Pond, Berlin.

[Number of organisms per cubic centimeter.]

	1897. Feb.	Feb.	Apr.	June.	Aug.	Oct.	Dec.
Day of examination,	12	19	7	12	11	13	14
Number of sample,	18474	18515	18964	19451	20043	20762	21503
PLANTS.							
Diatomaceæ,	**0**	**0**	**40**	**1**	**51**	**114**	**1,207**
Melosira,	0	0	5	0	0	72	24
Tabellaria,	0	0	18	1	37	20	1,168

HUDSON.

Microscopical Examination of Water from Gates Pond, Berlin — Concluded.

[Number of organisms per cubic centimeter.]

	1897.						
	Feb.	Feb.	Apr.	June.	Aug.	Oct.	Dec.
PLANTS — Con.							
Cyanophyceæ,	0	0	0	54	0	0	1
Anabæna,	0	0	0	32	0	0	0
Microcystis,	0	0	0	22	0	0	1
Algæ,	0	0	1	61	29	16	44
Protococcus,	0	0	1	52	15	10	22
ANIMALS.							
Infusoria,	4	20	6	452	34	40	362
Dinobryon,	4	20	3	452	34	36	356
Euglena,	0	0	0	0	0	2	0
Vermes, Anurea,	0	0	0	0	1	0	0
Miscellaneous, Zoöglœa,	0	0	0	0	5	10	0
TOTAL,	4	20	47	568	120	180	1,614

Chemical Examination of Water from Fosgate Brook, in Berlin.

[Parts per 100,000.]

Number.	Date of Collection.	Appearance.			Residue on Evaporation.		Ammonia.				Chlorine.	Nitrogen as		Oxygen Consumed.	Hardness.
								Albuminoid.							
		Turbidity.	Sediment.	Color.	Total.	Loss on Ignition.	Free.	Total.	Dissolved.	Sus-pended.		Nitrates.	Nitrites.		
	1897.														
18473	Feb. 10	Slight.	Slight.	1.70	5.80	3.40	.0006	.0420	.0384	.0036	.21	.0070	.0000	1.39	1.1
18496	Feb. 15	V. slight.	Slight.	1.80	5.60	3.20	.0012	.0352	.0344	.0008	.22	.0030	.0000	1.92	1.6
19018	Apr. 13	V. slight.	Slight.	1.20	3.75	1.95	.0004	.0206	.0198	.0008	.14	.0030	.0000	0.96	0.6
19449	June 11	None.	Slight.	2.96	7.00	5.00	.0008	.0512	.0498	.0014	.05	.0040	.0000	2.64	1.3
18472	Feb. 10	V. slight.	Slight.	2.00	6.20	4.05	.0022	.0420	.0398	.0022	.20	.0080	.0000	1.72	1.4
18497	Feb. 15	-	-	1.90	-	-	.0008	.0382	-	-	-	-	-	-	-
19016	Apr. 13	Slight.	Slight.	1.80	4.60	2.55	.0004	.0318	.0294	.0024	.10	.0030	.0001	1.47	0.6
19447	June 11	None.	Slight.	3.10	7.45	5.45	.0022	.0610	.0562	.0048	.04	.0020	.0000	3.01	1.7
18499	Feb. 15	-	-	2.00	-	-	.0012	.0382	-	-	-	-	-	-	-
18498	Feb. 15	-	-	0.55	-	-	.0000	.0150	-	-	-	-	-	-	-
18500	Feb. 15	-	-	0.50	-	-	.0000	.0194	-	-	-	-	-	-	-
19017	Apr. 13	V. slight.	Slight.	0.22	2.45	0.80	.0006	.0072	.0064	.0008	.16	.0030	.0000	0.24	0.5
19448	June 11	V. slight.	Slight.	0.47	2.70	1.10	.0020	.0158	.0142	.0016	.10	.0000	.0001	0.52	0.6
18475	Feb. 10	V. slight.	Cons., earthy.	0.08	2.80	0.85	.0016	.0124	.0070	.0054	.23	.0030	.0000	0.17	0.6
19450	June 11	V. slight.	Cons.	0.15	3.80	1.00	.0006	.0140	.0094	.0046	.29	.0020	.0000	0.24	1.3

The odor of Nos. 18497, 18499, 18498 and 18500 was not determined. The odor of the other samples was faintly vegetable, becoming somewhat stronger on heating. —— The samples were collected as follows: Nos. 18473, 18496, 19018 and 19449, from Fosgate Brook, at the proposed point of diversion into Gates Pond, just above the road leading to the pond; Nos. 18472, 18497, 19016 and 19447, from Fosgate Brook, above its junction with east branch; No. 18499, from Fosgate Brook, at outlet of swamp, about ¼ mile above junction with east branch; Nos. 18498, 18500, 19017 and 19448, from east branch of Fosgate Brook, above junction with west branch; Nos. 18475 and 19450, from a small brook at site of proposed dam below the outlet of Gates Pond.

HUDSON.

Table showing Heights of Water in Gates Pond Each Month during 1897.

[High-water mark is 14 feet.]

DATE — 1897.	Feet.	DATE — 1897.	Feet.
Jan. 15,	9.83	July 15,	10.83
Feb. 15,	10.00	Aug. 15,	10.58
March 15,	10.08	Sept. 15,	10.25
April 15,	11.25	Oct. 15,	9.75
May 15,	11.25	Nov. 15,	9.29
June 15,	11.00	Dec. 15,	9.50

Water Supply of Hull.

(See *Hingham.*)

Huntington.

The advice of the State Board of Health to the town of Huntington, with reference to a proposed water supply for the town, may be found on pages 22 to 24 of this volume. The results of analyses of samples of water collected from various sources in the town and vicinity are given in the following tables : —

Chemical Examination of Water from a Spring in Huntington.

[Parts per 100,000.]

Number.	Date of Collection.	Appearance.			Residue on Evaporation.	Ammonia.		Chlorine.	Nitrogen as		Oxygen Consumed.	Hardness.	Iron.
		Turbidity.	Sediment.	Color.		Free.	Albuminoid.		Nitrates.	Nitrites.			
	1897.												
21084	Nov. 8	V. slight.	Slight.	.30	3.20	.0006	.0066	.15	.0020	.0001	.28	2.1	.0010

Odor, none. —— The sample was collected from a faucet in the town, supplied from a spring on the hillside, south of Westfield River. Water from this spring is supplied to about fifty families in the village of Huntington.

HUNTINGTON.

Chemical Examination of Water from Various Surface Water Sources in Huntington and Vicinity.

[Parts per 100,000.]

Number.	Date of Collection.	Appearance.			Residue on Evaporation.		Ammonia.				Chlorine.	Nitrogen as		Oxygen Consumed.	Hardness.
		Turbidity.	Sediment.	Color.	Total.	Loss on Ignition.	Free.	Albuminoid. Total.	Albuminoid. Dissolved.	Albuminoid. Suspended.		Nitrates.	Nitrites.		
	1897.														
20979	Oct. 26	None.	None.	.10	2.95	0.60	.0004	.0028	.0028	.0000	.15	.0000	.0000	.11	1.3
20980	Oct. 26	None.	None.	.10	3.85	0.90	.0024	.0062	.0052	.0010	.13	.0180	.0000	.11	2.1
20981	Oct. 26	None.	V. slight.	.18	3.20	0.65	.0018	.0060	.0026	.0034	.13	.0080	.0000	.16	1.1
20982	Oct. 26	None.	None.	.15	2.30	0.70	.0032	.0148	.0128	.0020	.09	.0150	.0000	.17	1.1
21082	Nov. 8	None.	V. slight.	.19	4.30	1.25	.0006	.0060	.0060	.0000	.15	.0070	.0001	.20	2.3
21083	Nov. 8	None.	V. slight.	.30	3.85	1.45	.0006	.0112	.0112	.0000	.18	.0020	.0001	.49	1.3

Odor of Nos. 21082 and 21083, none; of the others, very faintly vegetable. —— The samples were collected as follows: No. 20979, from Taylor Brook, just below its junction with Clark Brook; No. 20980, from Cook Brook, about a mile above its mouth; No. 20981, from Cold Brook, about 1¼ miles above its mouth; No. 20982, from Norwich Pond, at its outlet; No. 21082, from Woodruff Brook, at highway bridge near its mouth; No. 21083, from Gold-mine Brook, at railroad bridge near its mouth.

Water Supply of Hyde Park and Milton. — Hyde Park Water Company.

Chemical Examination of Water from the Wells of the Hyde Park Water Company.

[Parts per 100,000.]

Number.	Date of Collection.	Appearance.			Residue on Evaporation.	Ammonia.		Chlorine.	Nitrogen as		Oxygen Consumed.	Hardness.	Iron.
		Turbidity.	Sediment.	Color.		Free.	Albuminoid.		Nitrates.	Nitrites.			
	1897.												
18292	Jan. 19	None.	None.	.02	10.20	.0064	.0044	1.24	.1100	.0003	.05	3.6	.0110
18513	Feb. 16	None.	V. slight.	.02	9.60	.0066	.0026	1.24	.0880	.0002	.04	3.6	.0180
18800	Mar. 16	None.	None.	.02	8.70	.0044	.0034	1.22	.1100	.0002	.05	3.5	.0120
19089	Apr. 21	None.	None.	.00	8.30	.0064	.0024	0.98	.1050	.0002	.08	3.4	.0050
19265	May 18	None.	None.	.00	8.40	.0052	.0020	1.08	.2200	.0000	.06	3.8	.0000
19542	June 22	None.	None.	.02	9.20	.0062	.0022	1.07	.1200	.0001	.07	3.8	.0030
19830	July 20	None.	None.	.03	10.60	.0082	.0040	1.14	.1000	.0004	.08	3.6	.0040
20121	Aug. 17	None.	V. slight.	.04	10.20	.0122	.0042	1.33	.0850	.0002	.13	4.4	.0060
20569	Sept. 21	None.	None.	.00	10.80	.0136	.0054	1.42	.1000	.0001	.14	5.0	.0050
20903	Oct. 20	None.	V. slight	.05	11.40	.0138	.0042	1.58	.1200	.0005	.10	4.9	.0230
21249	Nov. 16	V. slight.	Slight.	.11	10.90	.0160	.0056	1.69	.1200	.0003	.11	5.7	.0040
21619	Dec. 21	V. slight.	V. slight.	.13	11.00	.0130	.0042	1.58	.1260	.0005	.10	4.9	.0160

Averages by Years.

-	1888	-	-	.00	6.06	.0001	.0023	0.75	.0641	.0002	-	-	-
-	1893	-	-	.02	8.62	.0031	.0032	1.19	.0879	.0002	.10	3.7	.0112
-	1894	-	-	.03	9.68	.0040	.0039	1.37	.0843	.0001	.09	3.9	.0175
-	1895	-	-	.04	9.44	.0063	.0035	1.31	.0867	.0001	.09	4.0	.0149
-	1896	-	-	.03	9.68	.0084	.0046	1.21	.0882	.0003	.11	4.1	.0141
-	1897	-	-	.04	9.94	.0093	.0037	1.30	.1170	.0002	.08	4.2	.0089

Note to analyses of 1897: Odor, none. —— The samples were collected from a faucet at the pumping station.

HYDE PARK.

Chemical Examination of Water from a Faucet in Milton supplied from the Works of the Hyde Park Water Company.

[Parts per 100,000.]

Number.	Date of Collection.	Appearance. Turbidity.	Appearance. Sediment.	Appearance. Color.	Residue on Evaporation.	Ammonia. Free.	Ammonia. Albuminoid.	Chlorine.	Nitrogen as Nitrates.	Nitrogen as Nitrites.	Oxygen Consumed.	Hardness.	Iron.
	1897.												
18261	Jan. 18	V slight.	V. slight.	.00	11.40	.0002	.0038	1.46	.1050	.0000	.04	4.0	.0080
18433	Feb. 3	None.	None.	.02	11.20	.0000	.0034	1.47	.1200	.0000	.01	3.6	.0030
18700	Mar. 3	None.	None.	.00	9.30	.0000	.0026	1.40	.1100	.0000	.18	3.9	.0070
18981	Apr. 8	None.	None.	.00	8.80	.0000	.0030	1.28	.1300	.0000	.06	3.6	.0000
19187	May 7	None.	None.	.00	9.50	.0000	.0014	1.29	.1120	.0000	.03	3.8	.0000
19422	June 9	None.	None.	.00	10.00	.0008	.0040	1.26	.1150	.0000	.02	4.3	.0000
19730	July 7	None.	None.	.00	9.50	.0004	.0034	1.32	.1050	.0000	.14	4.2	.0000
20005	Aug. 5	None.	None.	.02	9.70	.0000	.0026	1.27	.1200	.0000	.02	4.3	.0000
20392	Sept. 8	None.	None.	.02	11.20	.0000	.0042	1.33	.0950	.0000	.09	4.6	.0040
20740	Oct. 6	None.	None.	.03	11.10	.0010	.0070	1.60	.0900	.0000	.07	4.3	.0010
21092	Nov. 9	None.	V. slight.	.12	11.40	.0006	.0068	1.95	.1300	.0001	.12	5.7	.0010
21477	Dec. 7	V. slight.	V. slight.	.06	11.20	.0012	.0054	1.80	.1340	.0000	.08	5.7	.0010
Av...	....	....	....	.02	10.36	.0003	.0040	1.45	.1138	.0000	.07	4.3	.0021

Odor, none.——The samples were collected from a faucet in the office of the Milton Water Company.

Chemical Examination of Water from the Neponset River at Hyde Park.

[Parts per 100,000.]

Number.	Date of Collection.	Appearance. Turbidity.	Appearance. Sediment.	Appearance. Color.	Residue on Evaporation. Total.	Residue on Evaporation. Loss on Ignition.	Ammonia. Free.	Ammonia. Albuminoid. Total.	Ammonia. Albuminoid. Dissolved.	Ammonia. Albuminoid. Suspended.	Chlorine.	Nitrogen as Nitrates.	Nitrogen as Nitrites.	Oxygen Consumed.	Hardness.
	1897.														
18291	Jan. 19	Distinct.	Slight.	0.70	7.05	2.45	.0008	.0250	.0204	.0046	0.88	.0170	.0002	0.79	2.3
18512	Feb. 16	Slight.	Slight.	0.75	6.45	2.35	.0010	.0272	.0230	.0042	0.96	.0150	.0002	0.80	1.8
18799	Mar. 16	V. slight.	Slight.	0.75	4.75	1.85	.0016	.0212	.0198	.0014	0.65	.0050	.0001	0.68	1.4
19088	Apr. 21	V. slight.	Slight.	1.20	4.95	2.05	.0092	.0264	.0250	.0014	0.59	.0050	.0001	0.56	1.7
19264	May 18	Slight.	Cons.	1.35	5.85	2.25	.0146	.0366	.0350	.0016	0.66	.0030	.0003	1.06	1.9
19541	June 22	Distinct.	Cons.	1.72	9.70	4.40	.0072	.0528	.0408	.0120	0.94	.0030	.0000	1.30	3.0
19829	July 20	V. slight.	Cons.	1.06	9.00	2.35	.0254	.0472	.0322	.0150	1.36	.0020	.0000	1.08	3.3
20120	Aug. 17	Slight.	Cons.	1.60	11.25	3.60	.0604	.0550	.0468	.0082	2.48	.0020	.0000	1.50	2.7
20568	Sept. 21	V. slight.	Cons.	1.10	13.75	3.45	.0450	.0502	.0466	.0036	2.24	.0020	.0000	1.21	5.0
20902	Oct. 20	Distinct.	Cons.	0.90	18.85	3.10	.0624	.0556	.0508	.0048	2.93	.0080	.0001	1.48	7.3
21248	Nov. 16	Decided.	Cons.	1.40	7.30	3.15	.0014	.0360	.0332	.0028	0.90	.0050	.0003	1.29	2.6
21618	Dec. 21	V. slight.	Cons.	1.70	6.60	3.10	.0030	.0294	.0266	.0028	0.80	.0130	.0001	1.14	2.1

Averages by Years.

–	1888	–	–	1.02	6.77	2.27	.0030	.0324	–	–	0.83	.0095	.0002	–	–
–	1893	–	–	1.16	7.70	2.49	.0151	.0320	.0254	.0066	1.19	.0154	.0005	0.95	2.4
–	1894	–	–	1.14	9.68	2.69	.0112	.0360	.0277	.0083	1.64	.0062	.0002	1.00	3.0
–	1895	–	–	1.04	8.40	2.81	.0182	.0365	.0312	.0053	1.18	.0064	.0001	1.05	3.0
–	1896	–	–	1.12	8.35	2.69	.0137	.0353	.0315	.0038	1.22	.0077	.0001	1.06	2.7
–	1897	–	–	1.19	8.79	2.84	.0193	.0385	.0333	.0052	1.28	.0067	.0001	1.07	2.9

NOTE to analyses of 1897: Odor, distinctly vegetable and musty, frequently unpleasant, becoming stronger on heating.——The samples were collected from the river, opposite the works of the Hyde Park Water Company. The river is not used directly as a source of water supply.

IPSWICH.

WATER SUPPLY OF IPSWICH.

Chemical Examination of Water from Dow's Brook above the Storage Reservoir of the Ipswich Water Works.

[Parts per 100,000.]

Number.	Date of Collection.	Appearance.			Residue on Evaporation.		Ammonia.				Chlorine.	Nitrogen as		Oxygen Consumed.	Hardness.
								Albuminoid.							
		Turbidity.	Sediment.	Color.	Total.	Loss on Ignition	Free.	Total.	Dissolved.	Sus-pended.		Nitrates.	Nitrites.		
	1897.														
18346	Jan. 25	V. slight.	Cons.	.30	4.80	1.95	.0018	.0108	.0078	.0030	.62	.0050	.0000	.31	1.7
18604	Feb. 22	V. slight.	Slight.	.35	4.45	1.80	.0008	.0096	.0096	.0000	.53	.0030	.0000	.36	1.4
18835	Mar. 23	V. slight.	Slight.	.70	3.90	1.55	.0010	.0218	.0182	.0026	.54	.0030	.0002	.56	1.1
19110	Apr. 26	V. slight.	Cons.	.55	4.10	1.40	.0006	.0130	.0110	.0020	.52	.0000	.0000	.56	1.4
19308	May 24	V slight.	Slight.	.48	4.80	1.60	.0008	.0114	.0104	.0010	.50	.0050	.0000	.38	1.7
19525	June 21	V. slight.	Slight.	.61	4.65	1.80	.0010	.0148	.0122	.0026	.45	.0020	.0000	.57	1.4
19913	July 26	None.	V. slight.	.26	4.80	1.20	.0018	.0110	.0058	.0052	.60	.0200	.0000	.32	2.1
20248	Aug. 23	V. slight.	Slight.	.15	4.75	1.15	.0142	.0118	.0086	.0032	.54	.0070	.0003	.20	1.9
20646	Sept. 26	V. slight.	V. slight.	.30	5.25	1.65	.0000	.0076	.0072	.0004	.61	.0060	.0000	.35	2.1
20947	Oct. 25	V. slight.	V. slight.	.66	5.15	1.75	.0030	.0246	.0228	.0018	–	.0150	.0000	.30	2.5
21340	Nov. 23	V. slight.	V. slight.	.60	5.10	1.85	.0010	.0136	.0136	.0000	.56	.0030	.0001	.64	1.8
21669	Dec. 27	V. slight.	Slight.	.32	4.15	1.80	.0010	.0072	.0070	.0002	.56	.0090	.0000	.27	1.8
Av...	....	....	....	.44	4.66	1.62	.0022	.0131	.0112	.0019	.55	.0065	.0000	.40	1.7

Odor of the last sample, none; of the others, vegetable. —— The samples were collected from the brook, at its entrance to the storage reservoir.

Chemical Examination of Water from the Storage Reservoir of the Ipswich Water Works.

[Parts per 100,000.]

Number.	Date of Collection.	Appearance.			Residue on Evaporation.		Ammonia.				Chlorine.	Nitrogen as		Oxygen Consumed.	Hardness.
								Albuminoid.							
		Turbidity.	Sediment.	Color.	Total.	Loss on Ignition.	Free.	Total.	Dissolved.	Sus-pended.		Nitrates.	Nitrites.		
	1897.														
18347	Jan. 25	Slight.	V. slight.	.40	5.85	2.30	.0030	.0244	.0228	.0016	.65	.0050	.0001	.45	1.6
18605	Feb. 22	Slight	V. slight.	.20	4.40	1.75	.0004	.0194	.0136	.0058	.77	.0030	.0000	.25	1.2
18836	Mar. 23	V. slight.	V. slight	.02	0.60	0.15	.0026	.0082	.0074	.0008	.19	.0020	.0000	.07	0.0
19111	Apr. 26	Slight.	Cons	.38	3.95	1.00	.0038	.0188	.0164	.0024	.64	.0070	.0000	.39	1.4
19309	May 24	V. slight.	V slight.	.43	4.80	1.70	.0012	.0162	.0156	.0006	.62	.0050	.0000	.46	1.3
19526	June 21	V. slight.	Slight.	.54	4.85	1.95	.0010	.0192	.0156	.0036	.52	.0030	.0002	.57	1.4
19914	July 26	None.	V. slight.	.33	5.00	1.60	.0002	.0208	.0150	.0058	.67	.0120	.0000	.45	2.1
20249	Aug. 23	V. slight.	Slight.	.14	4.90	1.60	.0028	.0208	.0188	.0020	.61	.0020	.0000	.35	1.7
20647	Sept. 26	V. slight.	V. slight.	.30	5.05	1.80	.0016	.0190	.0164	.0026	.66	.0000	.0000	.36	2.3
20948	Oct. 25	V. slight.	V. slight.	.32	5.20	1.90	.0030	.0238	.0202	.0036	.68	.0130	.0000	.32	2.2
21313	Nov. 22	Slight.	Slight.	.45	5.35	1.75	.0056	.0220	.0192	.0028	.71	.0080	.0001	.43	2.5
21670	Dec. 27	Slight.	V. slight.	.50	5.70	2.20	.0026	.0226	.0218	.0008	.78	.0100	.0000	.53	2.1
Av...	....	....	....	.33	4.64	1.64	.0023	.0196	.0169	.0027	.62	.0058	.0000	.39	1.6

Odor, generally vegetable, sometimes mouldy. —— The samples were collected from the reservoir.

IPSWICH.

Microscopical Examination of Water from the Storage Reservoir of the Ipswich Water Works.

[Number of organisms per cubic centimeter.]

	1897.											
	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Oct.	Oct.	Nov.	Dec.
Day of examination,	27	24	25	27	26	22	28	24	4	26	23	28
Number of sample,	18347	18605	18836	19111	19309	19526	19914	20249	20647	20948	21313	21670
PLANTS.												
Diatomaceæ,	0	6	0	8	4	12	1	0	5	2	4	1
Algæ,	24	0	0	0	6	385	1	0	2	9	0	0
Staurogenia,	0	0	0	0	0	380	0	0	0	0	0	0
Fungi, Crenothrix,	0	0	0	0	0	0	0	0	100	0	0	0
ANIMALS.												
Infusoria,	32	68	4	44	6	29	24	1	4	5	150	8
Dinobryon,	4	0	3	43	0	0	0	0	0	0	148	0
Peridinium,	20	68	1	0	5	28	15	0	1	1	0	8
Vermes, Anurea,	0	0	0	0	0	0	0	0	0	0	0	1
Crustacea, Cyclops,	0	0	0	0	0	0	0	0	0	pr.	0	0
Miscellaneous, Zoöglœa,	0	10	0	40	30	0	60	10	0	3	3	0
TOTAL,	56	84	4	92	46	426	86	11	111	19	157	10

Chemical Examination of Water from Bull Brook, Ipswich.

[Parts per 100,000.]

Number.	Date of Collection.	Appearance.			Residue on Evaporation.		Ammonia.				Chlorine.	Nitrogen as		Oxygen Consumed.	Hardness.
								Albuminoid.							
		Turbidity.	Sediment.	Color.	Total.	Loss on Ignition.	Free.	Total.	Dissolved.	Sus-pended		Nitrates.	Nitrites.		
	1897.														
18345	Jan. 25	V. slight.	Slight.	1.20	6.95	3.60	.0008	.0234	.0232	.0002	.88	.0080	.0000	0.99	1.7
18603	Feb. 22	V. slight.	V. slight.	1.15	6.15	2.85	.0016	.0194	.0194	.0000	.75	.0070	.0000	0.86	2.9
18834	Mar. 23	V. slight.	V. slight.	1.30	4.60	2.40	.0016	.0252	.0226	.0026	.54	.0050	.0002	1.01	1.1
19109	Apr. 26	V. slight.	Cons.	1.75	5.85	2.80	.0010	.0310	.0298	.0012	.65	.0030	.0000	1.30	1.9
19307	May 24	V. slight.	Slight.	2.20	7.00	3.15	.0010	.0290	.0288	.0002	.62	.0070	.0001	1.39	2.2
19524	June 21	V. slight.	V. slight.	1.73	6.45	3.00	.0000	.0292	.0260	.0032	.52	.0030	.0000	1.18	2.0
19912	July 26	None.	V. slight.	2.35	8.85	4.00	.0012	.0414	.0398	.0016	.76	.0150	.0001	2.19	2.6
20247	Aug. 23	V. slight.	Slight.	0.62	6.40	1.90	.0030	.0168	.0162	.0006	.72	.0050	.0000	0.49	2.6
20645	Sept. 26	V. slight.	V. slight.	1.80	8.45	3.55	.0014	.0290	.0278	.0012	.80	.0020	.0001	1.41	2.6
20946	Oct. 25	V. slight.	Cons.	0.60	6.65	2.10	.0046	.0158	.0158	.0000	.76	.0100	.0000	0.44	3.0
21312	Nov. 22	V. slight.	Slight.	1.50	8.70	3.85	.0030	.0304	.0286	.0018	.81	.0060	.0002	1.31	2.4
21668	Dec. 27	Slight.	V. slight.	1.08	6.25	2.65	.0024	.0196	.0186	.0010	.78	.0110	.0000	0.81	2.3
Av.	....	....	....	1.44	6.87	2.99	.0018	.0258	.0247	.0011	.72	.0068	.0001	1.11	2.3

Odor, generally distinctly vegetable. —— The samples were collected from the brook, near its junction with Dow's Brook, below the storage reservoir of the Ipswich water works. This brook is not used as a source of water supply, but a connection has been made, so that it can be diverted into the storage reservoir of the Ipswich water works.

KINGSTON.

Water Supply of Kingston.

The sources of supply of the town of Kingston were increased during the year 1897 by sinking 25 tubular wells in the valley of Furnace Brook, about a mile above the well and filter-gallery from which the supply for the town has previously been obtained. The wells are $2\frac{1}{2}$ inches in diameter, and are sunk to depths varying from 23 to 44 feet beneath the surface. Water is conveyed from the tubular wells to the large well near the pumping station by gravity through one mile of cast-iron pipe 8 inches and 10 inches in diameter. Water from this source was first used in December, 1897.

The advice of the State Board of Health to the town of Kingston, with reference to the use of water taken from the ground in this vicinity, may be found on pages 21 to 23 of the annual report for the year 1896, and analyses of samples of water from tubular test wells driven in the valley of the brook may be found on page 189 of that volume.

Chemical Examination of Water from Faucets supplied from the Kingston Water Works.

[Parts per 100,000.]

Number.	Date of Collection.	Appearance.			Residue on Evaporation.	Ammonia.		Chlorine.	Nitrogen as		Oxygen Consumed.	Hardness.	Iron.
		Turbidity.	Sediment.	Color.		Free.	Albuminoid.		Nitrates.	Nitrites.			
	1897.												
18335	Jan. 22	V. slight.	V. slight.	.05	5.10	.0004	.0038	.88	.0400	.0000	.12	1.4	.0100
18839	Mar. 22	V. slight.	V. slight.	.07	5.60	.0074	.0020	.95	.0300	.0030	.03	1.6	.0280
19312	May 25	V. slight.	Cons.	.12	4.80	.0024	.0020	.88	.0770	.0000	.07	1.7	.0250
19816	July 19	None.	None.	.01	5.60	.0002	.0034	.85	.0550	.0000	.07	1.8	.0010
20689	Oct. 1	None.	None.	.00	5.20	.0006	.0032	.84	.0700	.0001	.03	1.9	.0040
21359	Nov. 24	None.	V. slight.	.06	5.60	.0020	.0050	.96	.1040	.0000	.08	2.2	.0020
Av...	1897	....	....	.05	5.32	.0022	.0032	.89	.0627	.0005	.07	1.8	.0117
Av...	1896	....	....	.15	5.09	.0018	.0036	.84	.0438	.0000	.19	1.5	.0318

NOTE to analyses of 1897: Odor, none.—— The samples were collected from faucets in the town.

Microscopical Examination.

The organism *Crenothrix* was found in the first four samples in large numbers. No organisms were found in the remaining samples.

Water Supply of Lancaster.

(See *Clinton.*)

Water Supply of Lawrence.

The following tables contain analyses of the unfiltered Merrimack River water, and of the filtered water at the pumping station and at the distributing reservoir. The results of more extended chemical and biological examinations of the water before and after filtration through the sand filter may be found in a subsequent portion of this report, in the chapter on "Filtration of Water."

Chemical Examination of Water from the Merrimack River above Lawrence, opposite the Intake of the Lawrence Water Works.

[Parts per 100,000.]

Number.	Date of Collection.	Appearance.			Residue on Evaporation.		Ammonia.				Chlorine.	Nitrogen as		Oxygen Consumed.	Hardness.
		Turbidity.	Sediment.	Color.	Total.	Loss on Ignition.	Free.	Albuminoid Total.	Albuminoid Dissolved.	Albuminoid Sus-pended.		Nitrates.	Nitrites.		
	1897.														
18306	Jan. 20	Distinct.	Cons.	.38	4.70	1.50	.0074	.0206	.0196	.0010	.25	.0150	.0002	.46	1.3
18529	Feb. 17	Slight.	Cons., earthy.	.40	3.85	1.50	.0050	.0434	.0214	.0220	.23	.0070	.0001	.57	1.3
18793	Mar. 16	Distinct.	Cons.	.50	3.65	1.20	.0018	.0180	.0166	.0014	.17	.0070	.0001	.55	0.9
19092	Apr. 21	Distinct.	Cons.	.53	2.65	1.05	.0044	.0168	.0134	.0034	.10	.0070	.0000	.32	0.5
19291	May 19	Slight.	Slight.	.70	3.25	1.65	.0030	.0208	.0190	.0018	.12	.0030	.0001	.70	0.9
19488	June 16	V. slight.	Slight.	.67	3.20	1.55	.0028	.0192	.0166	.0026	.06	.0020	.0001	.69	0.6
19849	July 21	Slight.	Slight.	.85	3.40	1.45	.0048	.0224	.0198	.0026	.12	.0030	.0000	.74	1.0
20139	Aug. 18	Slight.	Cons.	.43	4.25	1.75	.0076	.0216	.0176	.0040	.22	.0070	.0001	.54	1.1
20614	Sept. 22	Slight.	Slight.	.30	4.35	1.50	.0092	.0252	.0216	.0036	.34	.0030	.0003	.42	1.1
20906	Oct. 20	Slight.	Cons.	.38	4.45	1.45	.0102	.0218	.0166	.0052	.28	.0130	.0003	.41	1.1
21274	Nov. 17	Decided	Cons.	.88	4.70	2.30	.0018	.0232	.0218	.0014	.24	.0040	.0002	.40	1.3
21643	Dec. 23	Decided.	Cons.	.70	3.60	1.60	.0012	.0206	.0186	.0020	.22	.0100	.0002	.64	1.7

Averages by Years.

-	1888	-	-	.30	3.68	1.08	.0026	.0180	-	-	.18	.0094	.0002	-	-
-	1889	-	-	.30	3.09*	0.87*	.0030	.0176	.0144	.0032	.17	.0072	.0003	-	-
-	1890	-	-	.33	4.19†	1.48†	.0046	.0166	.0132	.0034	.17	.0089	.0001	-	1.6‡
-	1891	-	-	.27	3.79	1.32	.0040	.0152	.0121	.0031	.18	.0110	.0001	-	1.3
-	1892	-	-	.43	4.12	1.47	.0042	.0181	.0152	.0029	.18	.0105	.0001	-	1.4
-	1893	-	-	.42	3.86	1.48	.0057	.0181	.0141	.0040	.20	.0081	.0002	.53	1.1
-	1894	-	-	.37	3.70	1.30	.0062	.0167	.0141	.0026	.23	.0063	.0001	.44	1.2
-	1895	-	-	.51	4.34	1.75	.0064	.0249	.0185	.0064	.28	.0071	.0002	.59	1.4
-	1896	-	-	.42	3.98	1.52	.0068	.0220	.0183	.0037	.24	.0087	.0003	.53	1.2
-	1897	-	-	.56	3.84	1.54	.0049	.0228	.0186	.0042	.20	.0067	.0001	.54	1.1

* January to May. † August to December. ‡ July to December.

Note to analyses of 1897: Odor, generally distinctly vegetable, occasionally mouldy or musty. —— The samples were collected from the river, opposite the intake of the Lawrence water works, about 1 foot beneath the surface. For a record of the quantity of water flowing in the river on dates when samples of water were collected for analysis, see page 203. For a comparison of the analyses of the river water at Lowell and Lawrence for a series of years, see "Merrimack River," in the chapter on "Examination of Rivers."

LAWRENCE.

Chemical Examination of Water from the Merrimack River after passing through the Sand Filter of the Lawrence Water Works.

[Parts per 100,000.]

Number.	Date of Collection.	Appearance.			Residue on Evaporation.		Ammonia.				Chlorine.	Nitrogen as		Oxygen Consumed.	Hardness.
								Albuminoid.							
		Turbidity.	Sediment.	Color.	Total.	Loss on Ignition.	Free.	Total.	Dissolved.	Sus-pended.		Nitrates.	Nitrites.		
	1897.														
18307	Jan. 20	None.	V. slight.	.43	5.60	1.75	.0108	.0102	.0092	.0010	.31	.0300	.0001	.36	1.6
18531	Feb. 17	V. slight.	V. slight.	.68	5.80	1.55	.0210	.0122	.0122	.0000	.25	.0350	.0001	.35	2.2
18794	Mar. 16	Slight.	Slight.	.50	4.30	1.55	.0100	.0104	.0104	.0000	.22	.0180	.0001	.41	1.4
19093	Apr. 21	Slight.	Slight.	.63	4.90	1.35	.0154	.0116	.0098	.0018	.22	.0400	.0000	.33	2.2
19292	May 19	Distinct, clayey.	V. slight.	.45	5.45	1.90	.0114	.0102	.0092	.0010	.22	.0480	.0013	.37	2.5
19489	June 16	V. slight.	Slight.	.55	4.20	1.55	.0064	.0104	.0082	.0022	.11	.0350	.0000	.58	1.6
19851	July 21	Distinct, milky.	Slight, brown.	.56	5.85	2.10	.0140	.0118	.0092	.0026	.24	.0280	.0002	.47	2.3
20140	Aug. 18	Distinct, milky.	Cons.	.48	6.35	1.45	.0192	.0104	.0072	.0032	.30	.0480	.0003	.26	2.7
20615	Sept. 22	Slight.	Slight.	.30	4.50	1.65	.0064	.0116	.0098	.0018	.28	.0230	.0000	.30	1.4
20907	Oct. 20	V. slight.	V. slight.	.40	4.25	1.35	.0034	.0060	.0056	.0004	.29	.0230	.0000	.22	1.4
21275	Nov. 17	V. slight.	Slight.	.87	5.85	2.25	.0160	.0120	.0110	.0010	.30	.0320	.0000	.47	2.6
21645	Dec. 23	Slight.	Slight.	.90	5.00	1.75	.0138	.0130	.0128	.0002	.24	.0210	.0000	.46	2.3

Averages by Years.

-	1894	-	-	.39	6.10	1.41	.0103	.0094	.0081	.0013	.30	.0309	.0002	.29	2.8
-	1895	-	-	.50	5.95	1.70	.0146	.0108	.0094	.0014	.31	.0274	.0001	.36	2.7
-	1896	-	-	.40	5.43	1.64	.0121	.0099	.0079	.0020	.25	.0319	.0004	.32	2.4
-	1897	-	-	.56	5.17	1.68	.0123	.0108	.0095	.0013	.25	.0317	.0002	.38	2.0

Note to analyses of 1897: Odor, frequently none, occasionally vegetable or mouldy. —— The samples were collected from a faucet in the check-valve, just beyond the pump, and represent water from the river which has passed through the sand filter, mingled with a small amount of ground water, which enters through the bottom and sides of the filter and which contains considerable free ammonia and iron.

LAWRENCE.

Chemical Examination of Water from the Distributing Reservoir of the Lawrence Water Works.

[Parts per 100,000.]

Number.	Date of Collection.	Appearance.			Residue on Evaporation.		Ammonia.				Chlorine.	Nitrogen as		Oxygen Consumed.	Hardness.
		Turbidity.	Sediment.	Color.	Total.	Loss on Ignition.	Free.	Albuminoid. Total.	Albuminoid. Dissolved.	Albuminoid. Sus-pended.		Nitrates.	Nitrites.		
	1897.														
18308	Jan. 20	V. slight.	V. slight.	.42	5.95	2.00	.0082	.0116	.0098	.0018	.25	.0200	.0001	.36	1.7
18530	Feb. 17	V. slight.	V. slight.	.43	4.80	1.60	.0112	.0118	.0118	.0000	.27	.0280	.0001	.30	1.7
18795	Mar. 16	V. slight.	V. slight.	.40	4.30	1.15	.0070	.0094	.0092	.0002	.22	.0250	.0000	.31	1.6
19094	Apr. 21	V. slight.	V. slight.	.35	4.05	1.25	.0086	.0084	.0068	.0016	.16	.0280	.0000	.29	1.4
19293	May 19	V. slight.	Slight.	.35	3.40	1.45	.0014	.0104	.0076	.0028	.16	.0250	.0001	.35	1.3
19490	June 16	None.	V. slight.	.40	4.15	1.45	.0020	.0104	.0078	.0026	.10	.0320	.0000	.39	1.3
19850	July 21	V. slight.	V. slight.	.40	4.25	1.55	.0038	.0118	.0096	.0022	.21	.0250	.0000	.44	1.6
20141	Aug. 18	V. slight.	V. slight.	.33	4.35	1.50	.0024	.0108	.0090	.0018	.22	.0170	.0008	.35	1.7
20616	Sept. 22	V. slight.	V. slight.	.28	4.55	1.70	.0038	.0130	.0110	.0020	.26	.0250	.0001	.30	1.7
20908	Oct. 20	V. slight.	V. slight.	.20	4.50	1.40	.0006	.0062	.0062	.0000	.32	.0520	.0000	.22	1.6
21276	Nov. 17	V. slight.	Slight.	.45	4.70	1.75	.0044	.0106	.0098	.0008	.30	.0300	.0000	.42	2.3
21644	Dec. 23	V. slight.	Slight.	.49	4.40	1.60	.0078	.0100	.0086	.0014	.23	.0220	.0000	.40	2.2
Av...	....	....	....	.37	4.45	1.53	.0051	.0104	.0089	.0015	.22	.0274	.0001	.34	1.7

Odor, generally none, sometimes vegetable or mouldy. —— The samples were collected from a faucet at the gate-house, and represent water flowing out of the reservoir. The reservoir is supplied with filtered water.

Volume of Water flowing in the Merrimack River at Lawrence on the Dates when Samples of Water were collected for Analysis.

Date.	Volume flowing in the Merrimack River, in Cubic Feet per Second. Rate of Flow during Eleven Hours of the Day.	Volume flowing in the Merrimack River, in Cubic Feet per Second. Rate of Flow during Twenty-four Hours.	Date.	Volume flowing in the Merrimack River, in Cubic Feet per Second. Rate of Flow during Eleven Hours of the Day.	Volume flowing in the Merrimack River, in Cubic Feet per Second. Rate of Flow during Twenty-four Hours.
1897.			1897.		
Jan. 20, ...	4,550	3,104	July 21, ...	11,077	9,853
Feb. 17, ...	6,431	4,539	Aug. 18, ...	5,999	4,159
March 16, ...	11,587	10,365	Sept. 22, ...	4,141	2,804
April 21, ...	18,480	17,085	Oct. 20, ...	4,036	2,716
May 19, ...	10,986	9,481	Nov. 17, ...	7,902	6,231
June 16, ...	18,717	17,639	Dec. 23, ...	12,070	10,878

LEE.

Water Supply of Lee. — Berkshire Water Company.

The advice of the State Board of Health to the Berkshire Water Company, relative to taking an additional supply of water from Basin Pond Brook in that town, may be found on pages 24 and 25 of this volume. Samples of water collected from the present sources and the proposed additional source of supply are given in the following tables: —

Chemical Examination of Water from the Upper and Lower Reservoirs of the Berkshire Water Company.

[Parts per 100,000.]

Number.	Date of Collection.	Appearance.			Residue on Evaporation.		Ammonia.				Chlorine.	Nitrogen as		Oxygen Consumed.	Hardness.
		Turbidity.	Sediment.	Color.	Total.	Loss on Ignition.	Free.	Albuminoid. Total.	Albuminoid. Dissolved.	Albuminoid. Suspended.		Nitrates.	Nitrites.		
	1897.														
18697	Mar. 2	V. slight.	V. slight.	.35	3.00	1.05	.0050	.0126	.0124	.0002	.11	.0100	.0001	.41	1.1
20065	Aug. 9	Slight.	Slight.	.43	2.55	1.55	.0008	.0222	.0158	.0064	.05	.0030	.0000	.61	0.5
20066	Aug. 10	V. slight.	V. slight.	.37	3.85	1.95	.0002	.0122	.0110	.0012	.04	.0030	.0000	.46	1.9

Odor, faintly vegetable. An unpleasant odor was developed in the second sample, on heating. —— The first sample was collected from Codding Brook, just above its entrance to the lower reservoir of the Berkshire Water Company; the second sample, from the upper reservoir; and the last, from the lower reservoir.

Microscopical Examination.

No. 18697. No organisms.

No. 20065. Diatomaceæ, *Asterionella*, 24; *Diatoma*, 24; *Synedra*, 12. Rhizopoda, *Arcella*, 2. Infusoria, *Dinobryon*, 38; *Euglena*, 6; *Peridinium*, 46. Vermes, *Anurea*, 2. Miscellaneous, *Zoöglœa*, 20. Total, 174.

No. 20066. Diatomaceæ, *Diatoma*, 5; *Navicula*, 3; *Synedra*, 1. Total, 9.

Chemical Examination of Water from Basin Pond Brook in Lee.

[Parts per 100,000.]

Number.	Date of Collection.	Appearance.			Residue on Evaporation.		Ammonia.				Chlorine.	Nitrogen as		Oxygen Consumed.	Hardness.
		Turbidity.	Sediment.	Color.	Total.	Loss on Ignition.	Free.	Albuminoid. Total.	Albuminoid. Dissolved.	Albuminoid. Suspended.		Nitrates.	Nitrites.		
	1897.														
18696	Mar. 2	None.	V. slight	.43	3.50	1.10	.0010	.0096	.0096	.0000	.16	.0180	.0000	.50	1.2
18718	Mar. 6	V. slight.	Slight.	.52	2.75	0.90	.0010	.0120	.0112	.0008	.08	.0120	.0000	.55	0.9

Odor of the first sample, faintly vegetable; of the last, none, becoming faintly vegetable on heating. The samples were collected from Basin Pond Brook, at a road crossing about a mile above its mouth.

WATER SUPPLY OF LEICESTER WATER SUPPLY DISTRICT, LEICESTER.

Chemical Examination of Water from the Wells of the Leicester Water Supply District.

[Parts per 100,000.]

Number.	Date of Collection.	Appearance.			Residue on Evaporation.	Ammonia.		Chlorine.	Nitrogen as		Oxygen Consumed.	Hardness.	Iron.
		Turbidity.	Sediment.	Color.		Free.	Albuminoid.		Nitrates.	Nitrites.			
	1897.												
18381	Jan. 27	None.	None.	.08	4.50	.0012	.0050	.26	.0770	.0000	.19	1.7	.0000
18775	Mar. 15	None.	None.	.23	4.50	.0008	.0040	.24	.0480	.0000	.19	1.4	.0050
19349	June 1	None.	None.	.05	6.40	.0002	.0006	.20	.0480	.0000	.06	1.4	.0030
19832	July 20	None.	None.	.49	5.90	.0006	.0086	.24	.0300	.0000	.55	1.1	.0050
20491	Sept. 14	None.	None.	.12	4.50	.0002	.0024	.29	.0450	.0000	.05	2.1	.0250
21381	Nov. 26	None.	None.	.12	4.90	.0016	.0062	.30	.0980	.0000	.14	2.6	.0030
Av...	....	....	....	.18	5.12	.0008	.0045	.25	.0577	.0000	.20	1.7	.0068

Odor, none. —— The samples were collected from a faucet in the village.

Chemical Examination of Water from an Underdrain beneath the Sewers at Leicester.

[Parts per 100,000.]

Number.	Date of Collection.	Appearance.			Residue on Evaporation.	Ammonia.		Chlorine.	Nitrogen as		Oxygen Consumed.	Hardness.	Iron.
		Turbidity.	Sediment.	Color.		Free.	Albuminoid.		Nitrates.	Nitrites.			
	1897.												
18486	Feb. 10	V. slight.	Slight.	.03	14.30	.0152	.0086	2.36	.3500	.0010	.04	4.6	.0110
18805	Mar. 17	None.	None.	.02	14.40	.0170	.0038	2.67	.4000	.0005	.03	4.9	.0100
21586	Dec. 15	Decided.	Cons.	.18	19.50	.0408	.0200	2.12	.6000	.0022	.25	7.0	.2800
Av...	....	....	..........,	.08	16.07	.0243	.0108	2.38	.4500	.0012	.11	5.5	.1003

Odor of the first sample, none; of the second, none, becoming faintly mouldy on heating; of the last, decidedly musty and unpleasant. —— The samples were collected from the underdrain in Pine Street.

LENOX.'

Water Supply of Lenox. — Lenox Water Company.

Chemical Examination of Water from the Storage Reservoir of the Lenox Water Company.

[Parts per 100,000.]

Number.	Date of Collection.	Appearance.			Residue on Evaporation.		Ammonia.				Chlorine.	Nitrogen as		Oxygen Consumed.	Hardness.
		Turbidity.	Sediment.	Color.	Total.	Loss on Ignition.	Free.	Albuminoid.				Nitrates.	Nitrites.		
								Total.	Dissolved.	Sus-pended.					
21094	1897. Nov. 9	Slight.	Slight.	.12	9.50	1.75	.0010	.0138	.0122	.0016	.10	.0000	.0001	.18	7.6

Odor, none, becoming faintly vegetable on heating. —— The sample was collected from the reservoir on Williams River, near its outlet.

Microscopical Examination.

Diatomaceæ, *Navicula*, 4; *Synedra*, 9; *Tabellaria*, 15. Infusoria, *Ciliated infusorian*, 2; *Codonella*, 5; *Dinobryon*, 1,588. Vermes, *Anurea*, 1. Crustacea, *Cyclops*, .02. Total, 1,624.

Chemical Examination of Water from the Distributing Reservoir of the Lenox Water Company.

[Parts per 100,000.]

Number.	Date of Collection.	Appearance.			Residue on Evaporation.		Ammonia.				Chlorine.	Nitrogen as		Oxygen Consumed.	Hardness.
		Turbidity.	Sediment.	Color.	Total.	Loss on Ignition.	Free.	Albuminoid.				Nitrates.	Nitrites.		
								Total.	Dissolved.	Sus-pended.					
21095	1897. Nov. 9	V. slight.	Slight.	.06	6.70	1.00	.0004	.0078	.0054	.0024	.06	.0090	.0000	.06	5.0

Odor, none. —— The sample was collected from the reservoir.

Microscopical Examination.

Diatomaceæ, *Asterionella*, 516; *Cyclotella*, 2; *Navicula*, 7; *Synedra*, 48; *Tabellaria*, 20. Algæ, *Protococcus*, 16. Infusoria, *Codonella*, 2; *Dinobryon*, 20; *Peridinium*, 2. Vermes, *Anurea*, 4. Total, 637.

Water Supply of Leominster.

Chemical Examination of Water from Haynes Reservoir, Leominster.

[Parts per 100,000.]

Number.	Date of Collection.	Appearance.			Residue on Evaporation.		Ammonia.				Chlorine.	Nitrogen as		Oxygen Consumed.	Hardness.
		Turbidity.	Sediment.	Color.	Total.	Loss on Ignition.	Free.	Albuminoid.				Nitrates.	Nitrites.		
								Total.	Dissolved.	Sus-pended.					
	1897.														
18378	Jan. 27	Slight.	Slight.	.58	3.55	1.80	.0106	.0396	.0386	.0010	.20	.0050	.0001	.61	0.6
18847	Mar. 23	V. slight.	V. slight.	.10	1.75	0.55	.0022	.0182	.0124	.0058	.13	.0050	.0000	.20	0.0
19322	May 25	V. slight.	Slight.	.23	1.95	1.10	.0006	.0346	.0184	.0162	.14	.0000	.0000	.35	0.0
19944	July 28	Distinct.	Cons.	.30	2.50	1.25	.0026	.0442	.0258	.0184	.15	.0030	.0000	.46	0.3
20662	Sept. 28	V. slight.	Slight.	.30	2.25	1.60	.0002	.0428	.0284	.0144	.16	.0000	.0000	.48	0.3
21367	Nov. 23	Slight.	Heavy.	.38	2.35	1.50	.0030	.0374	.0292	.0082	.16	.0020	.0000	.47	0.5
Av...	....	....	....	.31	2.39	1.30	.0032	.0361	.0255	.0106	.16	.0025	.0000	.43	0.3

Odor, vegetable; in January, also unpleasant; in March and May, faintly fishy.—— The samples were collected from the reservoir. For monthly record of height of water in this reservoir, see page 210.

Microscopical Examination of Water from Haynes Reservoir, Leominster.

[Number of organisms per cubic centimeter.]

	1897.					
	Jan.	Mar.	May.	July.	Oct.	Nov.
Day of examination,	30	25	27	30	4	29
Number of sample,	18378	18847	19322	19944	20662	21367
PLANTS.						
Diatomaceæ,	**8**	**0**	**928**	**180**	**1,510**	**268**
Asterionella,	0	0	0	56	152	56
Melosira,	0	0	156	102	592	22
Synedra,	4	0	0	4	68	0
Tabellaria,	0	0	772	18	696	188
Cyanophyceæ,	**0**	**0**	**15**	**38**	**32**	**0**
Cœlosphærium,	0	0	2	26	0	0
Microcystis,	0	0	5	0	32	0
Algæ,	**0**	**0**	**285**	**66**	**174**	**58**
Eudorina,	0	0	232	0	2	0
Staurastrum,	0	0	0	0	92	12
ANIMALS.						
Infusoria,	**1,238**	**33**	**908**	**264**	**6**	**4**
Dinobryon,	1,232	4	900	0	0	0
Peridinium,	2	22	0	260	0	0
Vermes,	**3**	**0**	**2**	**4**	**0**	**4**
Crustacea,	**pr.**	**0**	**pr.**	**0**	**pr.**	**pr.**
Miscellaneous, Zoöglœa,	**50**	**0**	**100**	**100**	**160**	**25**
TOTAL,	1,299	33	2,238	652	1,882	359

LEOMINSTER.

Chemical Examination of Water from Morse Reservoir, Leominster.

[Parts per 100,000.]

Number.	Date of Collection.	Appearance. Turbidity.	Appearance. Sediment.	Appearance. Color.	Residue on Evaporation. Total.	Residue on Evaporation. Loss on Ignition.	Ammonia. Free.	Ammonia. Albuminoid. Total.	Ammonia. Albuminoid. Dissolved.	Ammonia. Albuminoid. Suspended.	Chlorine.	Nitrogen as Nitrates.	Nitrogen as Nitrites.	Oxygen Consumed.	Hardness.
	1897.														
18379	Jan. 27	V. slight.	V. slight.	.32	2.55	0.95	.0014	.0216	.0158	.0058	.15	.0030	.0000	.37	0.5
18848	Mar. 23	V. slight.	V. slight.	.28	1.95	0.50	.0000	.0078	.0064	.0014	.10	.0000	.0000	.25	0.0
19321	May 25	V. slight.	Slight.	.30	2.00	0.90	.0008	.0162	.0136	.0026	.11	.0000	.0000	.34	0.0
19945	July 28	V. slight.	Slight.	.33	2.40	1.10	.0014	.0210	.0178	.0032	.15	.0020	.0000	.49	0.3
20663	Sept. 28	V. slight.	Slight.	.40	2.30	1.50	.0004	.0306	.0222	.0084	.14	.0020	.0000	.41	0.5
21366	Nov. 23	V. slight.	Cons.	.50	2.65	1.65	.0030	.0254	.0216	.0038	.20	.0030	.0000	.49	0.5
Av...	....	....	....	.35	2.31	1.10	.0012	.0204	.0162	.0042	.14	.0017	.0000	.39	0.3

Odor, vegetable, occasionally mouldy. —— The samples were collected from the reservoir. Water from Haynes Reservoir has been diverted into Morse Reservoir since 1894. For monthly record of height of water in this reservoir, see page 210.

Chemical Examination of Water from Fall Brook, above the Fall Brook Reservoir.

[Parts per 100,000.]

Number.	Date of Collection.	Appearance. Turbidity.	Appearance. Sediment.	Appearance. Color.	Residue on Evaporation. Total.	Residue on Evaporation. Loss on Ignition.	Ammonia. Free.	Ammonia. Albuminoid. Total.	Ammonia. Albuminoid. Dissolved.	Ammonia. Albuminoid. Suspended.	Chlorine.	Nitrogen as Nitrates.	Nitrogen as Nitrites.	Oxygen Consumed.	Hardness.
	1896.														
18139	Dec. 15	None.	V. slight.	0.50	3.40	1.55	.0010	.0132	.0126	.0006	.20	.0000	.0000	.74	0.3
	1897.														
18222	Jan. 1	Slight.	Cons.	0.40	3.25	1.65	.0006	.0134	.0100	.0034	.20	.0070	.0000	.58	0.4
18375	Jan. 27	None.	V. slight.	0.40	3.40	1.05	.0008	.0102	.0096	.0006	.21	.0080	.0001	.45	0.5
18585	Feb. 22	V. slight.	V. slight.	0.48	3.05	1.60	.0006	.0094	.0094	.0000	.20	.0050	.0000	.50	0.5
18840	Mar. 23	V. slight.	V. slight.	0.45	2.15	0.95	.0010	.0124	.0114	.0010	.12	.0020	.0002	.45	0.8
19116	Apr. 27	V. slight.	Slight.	0.60	2.15	0.90	.0008	.0150	.0150	.0000	.14	.0000	.0000	.60	0.3
19318	May 25	V. slight.	V. slight.	1.00	3.20	2.15	.0004	.0236	.0234	.0002	.10	.0030	.0000	.94	0.2
19566	June 23	None.	Slight.	0.63	2.75	1.40	.0006	.0104	.0084	.0020	.15	.0030	.0000	.55	0.3
19941	July 28	None.	V. slight.	0.97	3.50	1.75	.0008	.0178	.0164	.0014	.16	.0020	.0000	.98	0.5
20288	Aug. 25	None.	V. slight.	0.66	3.60	1.80	.0004	.0150	.0138	.0012	.15	.0030	.0000	.84	0.3
21363	Nov. 23	None.	Slight.	0.50	3.25	1.85	.0006	.0136	.0124	.0012	.22	.0030	.0000	.29	0.8
21695	Dec. 29	None.	V. slight.	0.38	3.15	1.15	.0000	.0062	.0056	.0006	.20	.0130	.0000	.35	0.8
Av.*.	....	....	....	0.60	3.05	1.50	.0006	.0135	.0126	.0009	.17	.0038	.0000	.61	0.5

* Where more than one sample was collected in a month, the mean analysis for that month has been used in making the average.

Odor, generally distinctly vegetable. —— The samples were collected from Fall Brook, as it enters the reservoir.

LEOMINSTER.

Chemical Examination of Water from Fall Brook Reservoir, Leominster.

[Parts per 100,000.]

Number.	Date of Collection.	Appearance.			Residue on Evaporation.		Ammonia.				Chlorine.	Nitrogen as		Oxygen Consumed.	Hardness.
		Turbidity.	Sediment.	Color.	Total.	Loss on Ignition.	Free.	Albuminoid. Total.	Albuminoid. Dissolved.	Albuminoid. Sus-pended.		Nitrates.	Nitrites.		
	1896.														
18140	Dec. 15	Decided, clayey.	Slight.	.55	4.10	1.55	.0014	.0200	.0154	.0046	.27	.0070	.0002	.71	1.3
	1897.														
18223	Jan. 1	Decided, clayey.	Slight.	.60	4.80	2.25	.0008	.0258	.0174	.0084	.32	.0050	.0001	.82	1.4
18376	Jan. 27	Distinct.	V. slight.	.68	4.65	1.90	.0010	.0282	.0256	.0026	.33	.0050	.0001	.65	0.8
18586	Feb. 22	Slight, milky.	V. slight.	.60	4.70	2.15	.0030	.0240	.0202	.0038	.30	.0000	.0001	.68	0.9
18841	Mar. 23	Slight.	Cons.	.40	2.45	1.00	.0028	.0152	.0126	.0026	.14	.0070	.0002	.41	0.6
19117	Apr. 27	Slight.	Slight.	.30	2.20	1.00	.0006	.0144	.0122	.0022	.18	.0030	.0001	.42	0.5
19319	May 25	Slight.	Cons.	.30	2.60	1.35	.0006	.0228	.0138	.0090	.16	.0000	.0000	.40	0.2
19567	June 23	V. slight.	Slight.	.28	2.85	1.30	.0042	.0198	.0144	.0054	.18	.0000	.0000	.40	0.2
19942	July 28	None.	V. slight.	.20	2.60	1.15	.0072	.0190	.0154	.0036	.18	.0040	.0000	.46	0.3
20289	Aug. 25	Slight.	Slight.	.28	2.65	1.35	.0030	.0188	.0138	.0050	.16	.0030	.0000	.43	0.6
20660	Sept. 28	V. slight.	Slight.	.32	2.55	1.35	.0034	.0202	.0182	.0020	.15	.0000	.0000	.35	0.5
20965	Oct. 26	V. slight.	V. slight.	.30	2.75	1.50	.0032	.0196	.0184	.0012	.20	.0060	.0001	.34	0.8
21364	Nov. 23	None.	Cons.	.38	2.60	1.25	.0018	.0206	.0174	.0032	.22	.0050	.0000	.37	0.8
21696	Dec. 29	V. slight.	Slight.	.38	2.85	1.20	.0006	.0182	.0134	.0048	.26	.0070	.0000	.38	0.8
Av.*.	....	....	....	.38	3.05	1.40	.0025	.0200	.0159	.0041	.21	.0036	.0001	.47	0.7

* Where more than one sample was collected in a month, the mean analysis for that month has been used in making the average.

Odor, generally distinctly vegetable, occasionally sweetish and unpleasant. The iron was determined in ten samples, the average amount in parts per 100,000 being .0145. —— The samples were collected from the reservoir, from 1 to 5 feet beneath the surface. For monthly record of height of water in this reservoir, see page 210.

Microscopical Examination.

The organism *Dinobryon* was found in each of the first seven samples, the largest number found in any one sample being 616 per cubic centimeter in the sample collected January 1. An insignificant number of organisms was found in each of the other samples.

Chemical Examination of Water from Fall Brook Reservoir, Leominster, collected near the Bottom.

[Parts per 100,000.]

Number.	Date of Collection.	Appearance.			Residue on Evaporation.		Ammonia.				Chlorine.	Nitrogen as		Oxygen Consumed.	Hardness.
		Turbidity.	Sediment.	Color.	Total.	Loss on Ignition.	Free.	Albuminoid. Total.	Albuminoid. Dissolved.	Albuminoid. Sus-pended.		Nitrates.	Nitrites.		
	1897.														
18377	Jan. 27	Distinct.	Slight.	.68	5.60	2.05	.0058	.0264	.0216	.0048	.29	.0070	.0000	.61	1.6
18587	Feb. 22	Distinct.	Cons.	.90	6.50	2.70	.0268	.0342	.0206	.0136	.35	.0030	.0001	.72	2.2
18842	Mar. 23	Slight.	Cons.	.60	5.10	1.60	.0054	.0218	.0160	.0058	.22	.0030	.0004	.49	1.8
19118	April 27	Slight.	Slight.	.30	2.25	0.95	.0016	.0190	.0150	.0040	.18	.0030	.0002	.39	0.5
19320	May 25	Slight.	Cons.	.30	2.40	1.10	.0008	.0194	.0114	.0080	.16	.0030	.0000	.37	0.2
19568	June 23	V. slight.	Cons.	.35	3.20	1.40	.0104	.0208	.0160	.0048	.17	.0000	.0003	.40	1.0
19943	July 28	V. slight.	Cons.	.30	2.95	1.15	.0154	.0224	.0162	.0062	.18	.0020	.0000	.47	0.5
20290	Aug. 25	Distinct.	Slight.	.67	3.10	1.40	.0202	.0224	.0184	.0040	.14	.0020	.0000	.49	0.8
20661	Sept. 28	V. slight.	V. slight.	.30	2.60	1.35	.0032	.0220	.0206	.0014	.17	.0000	.0000	.33	0.3
20966	Oct. 26	V. slight.	V. slight.	.30	2.75	1.55	.0014	.0142	.0136	.0006	.19	.0190	.0001	.34	1.0
21365	Nov. 23	V. slight.	Cons.	.37	2.60	1.35	.0018	.0194	.0184	.0010	.18	.0030	.0001	.38	0.8
21697	Dec. 29	Slight.	Cons.	.36	2.70	1.10	.0014	.0164	.0158	.0006	.22	.0070	.0000	.38	0.8
Av...	....	....	....	.45	3.48	1.47	.0078	.0216	.0170	.0046	.20	.0043	.0001	.45	1.0

Odor, generally distinctly vegetable and occasionally also unpleasant. The iron was determined in ten samples, the average amount in parts per 100,000 being .0590. —— The samples were collected from the reservoir near the gate-house, about 1 foot from the bottom.

LEOMINSTER.

Table showing Heights of Water in the Storage Reservoirs of the Leominster Water Works on the First of Each Month in 1897.

Date — 1897.	Haynes Reservoir. High Water, 12.50 Feet	Morse Reservoir. High Water, 25.00 Feet.	Fall Brook Reservoir. High Water, 28.17 Feet.
	Feet.	Feet.	Feet.
Jan. 1,	10.00	13.50	16.50
Feb. 1,	10.50	13.83	17.00
March 1,	11.83	14.00	18.17
April 1,	12.50	25.00	23.29
May 1,	12.50	24.58	25.00
June 1,	12.50	24.00	27.17
July 1,	12.50	23.50	27.42
Aug. 1,	12.50	21.00	28.17
Sept. 1,	12.50	22.00	28.17
Oct. 1,	12.50	24.00	28.17
Nov. 1,	12.50	25.00	28.17
Dec. 1,	12.50	25.00	28.17

Water Supply of Lexington.

Chemical Examination of Water from Vine Brook, above the Storage Reservoir of the Lexington Water Works.

[Parts per 100,000.]

Number.	Date of Collection.	Appearance.			Residue on Evaporation.		Ammonia.				Chlorine.	Nitrogen as		Oxygen Consumed.	Hardness.
		Turbidity.	Sediment.	Color.	Total.	Loss on Ignition.	Free.	Albuminoid. Total.	Albuminoid. Dissolved.	Albuminoid. Suspended.		Nitrates.	Nitrites.		
	1897.														
18507	Feb. 15	V. slight.	V. slight.	.10	4.55	1.15	.0026	.0062	.0060	.0002	.45	.0280	.0001	.17	1.6

Odor, faintly vegetable, disappearing on heating. —— The sample was collected from the brook, at entrance to storage reservoir.

Chemical Examination of Water from the Vine Brook Storage Reservoir of the Lexington Water Works.

[Parts per 100,000.]

Number.	Date of Collection.	Appearance.			Residue on Evaporation.		Ammonia.				Chlorine.	Nitrogen as		Oxygen Consumed.	Hardness.
		Turbidity.	Sediment.	Color.	Total.	Loss on Ignition.	Free.	Albuminoid. Total.	Albuminoid. Dissolved.	Albuminoid. Suspended.		Nitrates.	Nitrites.		
	1897.														
18506	Feb. 15	V. slight.	V. slight.	.10	4.55	1.25	.0034	.0074	.0062	.0012	.44	.0280	.0000	0.20	1.7
19011	Apr. 12	Distinct.	Slight.	.38	3.95	1.35	.0016	.0204	.0164	.0040	.35	.0230	.0002	0.46	1.4
19459	June 14	Distinct.	V. slight.	.35	4.50	1.40	.0008	.0290	.0160	.0130	.36	.0230	.0001	0.49	1.7
20104	Aug. 16	Slight.	V. slight.	.38	6.10	3.10	.0018	.0480	.0328	.0152	.47	.0020	.0000	0.67	1.7
20825	Oct. 18	Distinct, green.	Cons., green.	.68	9.05	5.85	.0004	.0506	.0350	.0156	.48	.0480	.0000	1.32	1.4
21616	Dec. 21	Decided.	Slight.	.90	7.45	3.95	.0046	.0516	.0440	.0076	.56	.0150	.0001	0.96	1.8
Av..	....	....	....	.46	5.93	2.82	.0021	.0345	.0251	.0094	.44	.0232	.0001	0.68	1.6

Odor, generally vegetable, frequently fishy, occasionally musty or unpleasant. —— The samples were collected from the reservoir.

LEXINGTON.

Microscopical Examination of Water from the Vine Brook Storage Reservoir of the Lexington Water Works.

[Number of organisms per cubic centimeter.]

	1897.					
	Feb.	April.	June.	Aug.	Oct.	Dec.
Day of examination,	18	15	15	17	19	22
Number of sample,	18506	19011	19459	20104	20825	21616
PLANTS.						
Diatomaceæ,	4	70	77	56	60	0
Synedra,	1	48	68	10	52	0
Cyanophyceæ, Clathrocystis,	0	0	0	4	6	0
Algæ,	2	1	3	4	2	0
ANIMALS.						
Infusoria,	0	1,263	1,979	2	20	1
Dinobryon,	0	1,232	3	0	0	0
Mallomonas,	0	0	1,976	0	0	0
Peridinium,	0	28	0	0	2	1
Vermes,	0	2	2	4	2	0
Miscellaneous, Zoöglœa,	10	80	60	10	25	25
TOTAL,	16	1,416	2,121	80	115	26

Chemical Examination of Water from a Faucet at the Pumping Station of the Lexington Water Works.

[Parts per 100,000.]

Number.	Date of Collection.	Appearance.			Residue on Evaporation.		Ammonia.				Chlorine.	Nitrogen as		Oxygen Consumed.	Hardness.
								Albuminoid.							
		Turbidity.	Sediment.	Color.	Total.	Loss on Ignition.	Free.	Total.	Dissolved.	Sus-pended.		Nitrates.	Nitrites.		
	1897.														
19012	Apr.12	V. slight.	V. slight.	1.20	8.05	3.50	.0022	.0278	.0252	.0026	.49	.0850	.0000	1.09	2.7
19458	June14	V. slight.	V. slight.	1.90	9.05	3.85	.0018	.0336	.0316	.0020	.45	.0700	.0001	1.54	3.2
20105	Aug.16	None.	V. slight.	0.46	8.40	2.75	.0020	.0144	.0130	.0014	.67	.1000	.0001	0.52	3.6
20826	Oct. 18	V. slight.	Slight.	0.30	8.05	2.15	.0002	.0068	.0068	.0000	.62	.0930	.0000	0.29	3.9
21617	Dec. 21	V. slight.	V. slight.	0.93	8.60	3.95	.0016	.0198	.0198	.0000	.64	.1440	.0001	0.83	3.6
Av.	....	....	....	0.96	8.43	3.24	.0016	.0205	.0193	.0012	.57	.0984	.0001	0.85	3.4

Odor of the last two samples, none; of the others, vegetable.

WATER SUPPLY OF LINCOLN.

(See *Concord*.)

LONGMEADOW.

Water Supply of Longmeadow.

Chemical Examination of Water from Cooley Brook, Longmeadow.

[Parts per 100,000.]

Number.	Date of Collection.	Appearance.			Residue on Evaporation.		Ammonia.				Chlorine.	Nitrogen as		Oxygen Consumed.	Hardness.
		Turbidity.	Sediment.	Color.	Total.	Loss on Ignition.	Free.	Albuminoid.				Nitrates.	Nitrites.		
								Total.	Dissolved.	Suspended.					
	1897.														
18849	Mar. 22	V. slight.	Slight.	.07	4.15	0.95	.0016	.0060	.0044	.0016	.15	.0380	.0001	.09	2.1
19576	June 24	V. slight.	Slight.	.10	4.60	1.35	.0036	.0070	.0070	.0000	.14	.0350	.0001	.10	2.6
20741	Oct. 5	V. slight.	V. slight	.12	4.80	1.30	.0006	.0054	.0054	.0000	.15	.0300	.0001	.13	2.6
Av.	....	....	....	.10	4.52	1.20	.0019	.0061	.0056	.0005	.15	.0343	.0001	.11	2.4

Odor, faintly vegetable. —— The sample was collected from a faucet at the pumping station, while pumping.

Water Supply of Lowell.

Chemical Examination of Water from the Merrimack River above Lowell.

[Parts per 100,000.]

Number.	Date of Collection.	Appearance.			Residue on Evaporation.		Ammonia.				Chlorine.	Nitrogen as		Oxygen Consumed.	Hardness.
		Turbidity.	Sediment.	Color.	Total.	Loss on Ignition.	Free.	Albuminoid.				Nitrates.	Nitrites.		
								Total.	Dissolved.	Suspended.					
	1897.														
18295	Jan. 19	Slight.	Slight.	.32	4.45	1.60	.0050	.0178	.0174	.0004	.19	.0030	.0005	.39	1.4
18521	Feb. 15	V. slight	V. slight	.40	3.45	1.35	.0034	.0166	.0162	.0004	.13	.0080	.0000	.48	1.1
18789	Mar. 16	Distinct, clayey.	Cons.	.40	3.60	1.10	.0020	.0164	.0142	.0022	.12	.0050	.0000	.54	0.8
19083	Apr. 20	Slight.	Cons.	.40	2.80	0.95	.0012	.0166	.0130	.0036	.07	.0070	.0001	.50	0.5
19276	May 18	Distinct.	Cons.	.63	3.05	1.30	.0032	.0200	.0184	.0016	.08	.0050	.0001	.62	0.8
19468	June 15	Slight.	Slight.	.62	3.10	1.70	.0006	.0174	.0118	.0056	.05	.0030	.0000	.74	0.5
19833	July 20	Slight.	Slight.	.88	3.60	1.85	.0022	.0184	.0144	.0040	.12	.0070	.0001	.82	0.5
20125	Aug. 17	V. slight.	Slight.	.43	3.70	1.55	.0038	.0156	.0122	.0034	.16	.0030	.0000	.52	0.9
20593	Sept. 21	V. slight.	V. slight.	.30	3.65	1.45	.0034	.0190	.0182	.0008	.22	.0050	.0001	.35	1.3
20885	Oct. 19	V. slight.	V. slight.	.32	3.55	1.40	.0044	.0164	.0120	.0044	.20	.0230	.0001	.33	1.0
21267	Nov. 16	Slight.	Cons.	.68	4.15	2.15	.0034	.0220	.0202	.0018	.21	.0050	.0001	.38	1.1
21661	Dec. 24	Slight.	Slight.	.65	3.35	1.15	.0036	.0164	.0160	.0004	.20	.0070	.0002	.53	1.6

Averages by Years.

–	1888	–	–	.30	3.42	0.97	.0016	.0148	–	–	.16	.0099	.0002	–	–
–	1889	–	–	.28	2.95*	0.84*	.0018	.0149	.0126	.0023	.14	.0071	.0002	–	–
–	1890	–	–	.30	3.57†	1.54†	.0014	.0128	.0104	.0024	.13	.0111	.0001	–	1.4
–	1891	–	–	.29	3.43	1.23	.0017	.0129	.0100	.0029	.13	.0137	.0001	–	1.2
–	1892	–	–	.39	3.61	1.36	.0021	.0141	.0113	.0028	.14	.0092	.0001	–	1.3
–	1893	–	–	.33	3.39	1.18	.0026	.0149	.0120	.0029	.17	.0083	.0001	.44	1.1
–	1894	–	–	.35	3.55	1.26	.0034	.0135	.0109	.0026	.18	.0063	.0001	.40	1.1
–	1895	–	–	.41	3.84	1.46	.0039	.0187	.0140	.0047	.21	.0066	.0001	.54	1.2
–	1896	–	–	.40	3.47	1.28	.0034	.0167	.0136	.0031	.17	.0070	.0001	.52	1.0
–	1897	–	–	.50	3.54	1.46	.0030	.0177	.0153	.0024	.15	.0067	.0001	.52	1.0

* January to May. † September to December.

Note to analyses of 1897: Odor, generally distinctly vegetable and mouldy. —— The samples were collected from the river, opposite the intake of the Lowell Water Works.

For a comparison of the analyses of the river at Lowell and Lawrence for a series of years, see "Merrimack River," in the chapter on "Examination of Rivers," in a subsequent portion of this report. The river is not used directly as a source of water supply.

LOWELL.

Chemical Examination of Water from Tubular Wells in the Valley of River Meadow Brook, a Short Distance above Plain Street.

[Parts per 100,000.]

Number.	Date of Collection.	Appearance.			Residue on Evaporation.	Ammonia.		Chlorine.	Nitrogen as		Oxygen Consumed.	Hardness.	Iron.
		Turbidity.	Sediment.	Color.		Free.	Albuminoid.		Nitrates.	Nitrites.			
	1897.												
18296	Jan. 19	None.	None.	.00	9.20	.0002	.0030	.55	.0380	.0000	.07	3.2	.0060
18791	Mar. 15	None.	V. slight.	.02	8.40	.0004	.0038	.55	.0270	.0001	.05	3.6	.0100
19085	Apr. 20	None.	None.	.02	8.00	.0040	.0024	.54	.0500	.0002	.07	3.8	.0050
19469	June 15	None.	None.	.01	8.10	.0004	.0008	.54	.0750	.0000	.09	3.4	.0030
19835	July 20	None.	None.	.02	8.70	.0000	.0040	.56	.0450	.0000	.07	3.3	.0020
20126	Aug. 17	None.	None.	.03	8.10	.0006	.0038	.48	.0280	.0000	.11	3.5	.0040
20594	Sept. 21	None.	None.	.00	8.80	.0010	.0058	.55	.0170	.0000	.10	3.8	.0020
20886	Oct. 19	None.	None.	.05	8.50	.0004	.0020	.53	.0400	.0000	.06	3.8	.0030
21265	Nov. 16	None.	V. slight.	.06	9.60	.0012	.0056	.59	.0150	.0001	.09	4.6	.0030
21659	Dec. 24	None.	V. slight.	.01	9.70	.0000	.0034	.62	.0430	.0002	.08	4.4	.0030

Averages by Years.

–	1894	–	–	.02	7.33	.0003	.0014	.55	.0549	.0002	.02	2.8	.0078
–	1895	–	–	.02	9.22	.0001	.0024	.56	.0323	.0002	.05	3.8	.0119
–	1896	–	–	.02	8.37	.0002	.0035	.53	.0507	.0000	.09	3.8	.0068
–	1897	–	–	.02	8.71	.0008	.0035	.55	.0378	.0001	.08	3.7	.0041

NOTE to analyses of 1897: Odor, none.—The samples were collected from the wells, which are locally known as the "Cook" wells.

Chemical Examination of Water from Tubular Wells in the Valley of River Meadow Brook, a Short Distance above the Old Middlesex Canal in Chelmsford.

[Parts per 100,000.]

Number.	Date of Collection.	Appearance.			Residue on Evaporation.	Ammonia.		Chlorine.	Nitrogen as		Oxygen Consumed.	Hardness.	Iron.
		Turbidity.	Sediment.	Color.		Free.	Albuminoid.		Nitrates.	Nitrites.			
	1897.												
18522	Feb. 15	None.	V. slight.	.07	10.80	.0070	.0048	.32	.0080	.0001	.10	4.6	.0330
18792	Mar. 16	None.	None.	.10	11.00	.0064	.0054	.33	.0060	.0000	.07	5.3	.0570
19278	May 18	Distinct.	Cons., floc.	.25	10.60	.0086	.0050	.32	.0030	.0000	.15	4.9	.0850
20127	Aug. 17	Distinct, milky.	V. slight.	.36	9.50	.0072	.0052	.32	.0060	.0000	.25	4.3	.0450
21266	Nov. 16	Decided.	Heavy.	.21	10.00	.0092	.0080	.45	.0030	.0001	.19	4.7	.0350
21660	Dec. 24	Decided.	Cons.	.19	10.20	.0094	.0062	.38	.0060	.0001	.18	5.1	.0330

Averages by Years.

–	1895	–	–	.12	9.42	.0020	.0017	.31	.0073	.0000	.05	3.9	.0673
–	1896	–	–	.10	11.50	.0064	.0047	.32	.0071	.0001	.13	5.0	.0697
–	1897	–	–	.20	10.35	.0080	.0058	.35	.0053	.0000	.16	4.8	.0488

NOTE to analyses of 1897: Odor, none.—The samples were collected from a faucet at the pumping station, while pumping. These wells are locally known as the "Hydraulic Construction Company's" wells.

LOWELL.

Microscopical Examination of Water from Tubular Wells in the Valley of River Meadow Brook, a Short Distance above the Old Middlesex Canal in Chelmsford.

[Number of organisms per cubic centimeter.]

	1897.					
	Feb.	March.	May.	Aug.	Nov.	Dec.
Day of examination,	19	18	20	18	18	28
Number of sample,	18522	18792	19278	20127	21266	21660
PLANTS.						
Fungi, Crenothrix,	268	0	4,800	160	400	2,000

Chemical Examination of Water from Tubular Wells in the Valley of the Merrimack River near the Pawtucket Boulevard.

[Parts per 100,000.]

Number.	Date of Collection.	Appearance. Turbidity.	Appearance. Sediment.	Appearance. Color.	Residue on Evaporation.	Ammonia. Free.	Ammonia. Albuminoid.	Chlorine.	Nitrogen as Nitrates.	Nitrogen as Nitrites.	Oxygen Consumed.	Hardness.	Iron.
	1897.												
18297	Jan. 19	None.	V. slight.	.02	5.90	.0056	.0030	.28	.0280	.0000	.01	2.3	.0190
18540	Feb. 17	None.	None.	.05	4.60	.0080	.0032	.28	.0200	.0001	.03	2.1	.0300
18790	Mar. 16	None.	None.	.12	5.10	.0076	.0022	.29	.0300	.0000	.05	2.3	.0190
19084	Apr. 20	V. slight.	V. slight.	.05	4.50	.0086	.0022	.24	.0200	.0001	.08	2.1	.0180
19277	May 18	V. slight.	V. slight.	.12	3.70	.0086	.0028	.25	.0270	.0000	.02	1.7	.0200
19470	June 15	None.	None.	.04	4.00	.0070	.0030	.16	.0390	.0010	.08	1.6	.0130
19834	July 20	V. slight.	V. slight.	.14	4.00	.0120	.0044	.22	.0125	.0002	.05	1.4	.0250
20128	Aug. 17	None.	V. slight.	.14	4.70	.0142	.0036	.20	.0160	.0001	.09	1.7	.0250
20595	Sept. 21	None.	None.	.10	4.50	.0128	.0048	.22	.0150	.0000	.08	1.6	.0280
20887	Oct. 19	None.	V. slight.	.10	4.50	.0120	.0024	.27	.0480	.0000	.05	1.7	.0250
Av...	1897	....	....	.09	4.55	.0096	.0032	.24	.0255	.0001	.05	1.8	.0222
Av...	1896	....	....	.01	4.36	.0044	.0019	.30	.0452	.0001	.04	1.8	.0098

NOTE to analyses of 1897: Odor, none.—— The samples were collected from a faucet at the pumping station, while pumping. The wells are locally known as the "Boulevard" wells.

WATER SUPPLY OF LUDLOW.

(See *Springfield.*)

Water Supply of Lynn and Saugus.

Chemical Examination of Water from Breed's Pond, Lynn.

[Parts per 100,000.]

Number.	Date of Collection.	Appearance.			Residue on Evaporation.		Ammonia.				Chlorine.	Nitrogen as		Oxygen Consumed.	Hardness.
		Turbidity.	Sediment.	Color.	Total.	Loss on Ignition.	Free.	Albuminoid. Total.	Albuminoid. Dissolved.	Albuminoid. Suspended.		Nitrates.	Nitrites.		
	1897.														
18270	Jan. 18	V. slight.	Slight.	.42	4.45	1.75	.0066	.0194	.0176	.0018	.59	.0050	.0001	.54	1.1
18463	Feb. 9	V. slight.	V. slight.	.30	4.20	1.70	.0070	.0160	.0154	.0006	.96	.0080	.0002	.36	1.1
18636	Feb. 24	V. slight.	V. slight.	.42	3.80	1.55	.0034	.0154	.0138	.0016	.61	.0050	.0000	.46	0.8
18730	Mar. 9	V. slight.	V. slight.	.45	3.90	1.40	.0026	.0144	.0142	.0002	.62	.0070	.0000	.42	0.8
19020	Apr. 13	V. slight.	V. slight.	.68	3.85	1.40	.0020	.0160	.0138	.0022	.55	.0030	.0001	.48	0.6
19218	May 11	Slight.	V. slight.	.40	3.60	1.05	.0008	.0200	.0176	.0024	.57	.0030	.0000	.46	0.8
19411	June 8	V. slight.	Slight.	.58	3.35	1.30	.0014	.0270	.0228	.0042	.50	.0000	.0000	.51	0.8
19777	July 13	Slight.	V. slight.	.50	3.45	1.30	.0000	.0218	.0138	.0080	.49	.0020	.0000	.64	0.6
20057	Aug. 10	Slight.	V. slight.	.37	3.40	1.25	.0006	.0224	.0150	.0074	.55	.0030	.0000	.50	0.8
20479	Sept. 14	V. slight.	Slight.	.33	3.40	1.65	.0004	.0186	.0156	.0030	.56	.0000	.0000	.45	1.1
20785	Oct. 13	V. slight.	V. slight.	.32	3.30	1.30	.0042	.0254	.0208	.0046	.54	.0030	.0001	.41	1.3
21219	Nov. 10	Cons.	Cons.	.38	9.75	2.00	.0024	.0212	.0192	.0020	.60	.0030	.0002	.38	1.7
21566	Dec. 14	V. slight.	Slight.	.40	3.75	1.40	.0040	.0222	.0188	.0034	.58	.0080	.0000	.42	1.1

Averages by Years.

-	1888	-	-	.48	3.71	1.42	.0029	.0227	-	-	.45	.0053	.0001	-	-
-	1889	-	-	.45	3.09	1.02	.0007	.0208	.0165	.0043	.41	.0035	.0001	-	-
-	1890	-	-	.42	3.62	1.51	.0014	.0196	.0155	.0041	.41	.0052	.0001	-	1.1
-	1891	-	-	.35	3.35	1.37	.0009	.0156	.0131	.0025	.40	.0080	.0001	-	0.8
-	1892	-	-	.43	3.65	1.38	.0004	.0220	.0177	.0043	.49	.0055	.0000	-	1.0
-	1893	-	-	.65	3.61	1.41	.0039	.0214	.0181	.0033	.55	.0054	.0001	.51	1.1
-	1894	-	-	.65	3.77	1.47	.0023	.0225	.0191	.0034	.58	.0032	.0000	.53	0.9
-	1895	-	-	.48	3.75	1.48	.0016	.0199	.0171	.0028	.58	.0036	.0001	.50	0.9
-	1896	-	-	.39	3.57	1.36	.0023	.0181	.0152	.0029	.52	.0019	.0001	.47	0.7
-	1897*	-	-	.43	4.18	1.45	.0025	.0204	.0170	.0034	.58	.0036	.0000	.47	1.0

* Where more than one sample was collected in a month, the mean analysis for that month has been used in making the average.

Note to analyses of 1897: Odor, distinctly vegetable. —— The samples were collected from the pond, near the gate-house, about 1 foot beneath the surface. For monthly record of height of water in this pond, see page 225.

LYNN.

Microscopical Examination of Water from Breed's Pond, Lynn.

[Number of organisms per cubic centimeter.]

	1897.												
	Jan.	Feb.	Feb.	Mar.	Apr.	May.	June.	July.	Aug	Sept.	Oct.	Nov.	Dec.
Day of examination,	19	10	27	11	15	13	11	16	12	15	14	12	16
Number of sample,	18270	18463	18636	18730	19020	19218	19411	19777	20057	20479	20785	21219	21566
PLANTS.													
Diatomaceæ,	78	0	1	5	49	257	10	14	72	94	44	168	31
Asterionella,	78	0	0	5	39	140	0	8	0	80	8	140	10
Tabellaria,	0	0	0	0	9	116	0	6	36	0	8	8	12
Cyanophyceæ, Anabæna,	0	0	0	0	0	11	0	1	238	0	0	0	0
Algæ,	3	0	0	0	1	1	1	4	0	32	6	24	8
ANIMALS.													
Rhizopoda,	0	0	0	0	0	0	0	1	2	2	0	0	1
Infusoria,	4	1	34	7	34	346	10	2	2	14	14	0	9
Dinobryon,	0	0	0	0	32	244	10	1	0	0	4	0	0
Mallomonas,	2	0	0	0	0	24	0	0	0	0	6	0	5
Peridinium,	2	0	34	6	2	0	0	1	0	0	0	0	3
Raphidomonas,	0	0	0	0	0	44	0	0	0	0	0	0	0
Synura,	0	0	0	0	0	28	0	0	0	0	0	0	0
Vermes,	0	0	0	0	1	1	0	0	0	4	2	0	1
Crustacea,	0	0	0	0	0	pr.	0	pr.	pr.	0	0	pr.	0
Miscellaneous, Zoöglœa,	10	5	0	0	20	40	15	40	15	3	5	5	5
TOTAL,	95	6	35	12	105	656	36	62	329	149	71	197	55

Chemical Examination of Water from Birch Pond, Lynn.

[Parts per 100,000.]

Number.	Date of Collection.	Appearance.			Residue on Evaporation.		Ammonia.				Chlorine.	Nitrogen as		Oxygen Consumed.	Hardness.
		Turbidity.	Sediment.	Color.	Total.	Loss on Ignition.	Free.	Albuminoid. Total.	Albuminoid. Dissolved.	Albuminoid. Sus-pended.		Nitrates.	Nitrites.		
	1897.														
18269	Jan. 18	V. slight.	Slight.	0.20	2.90	1.00	.0050	.0124	.0100	.0024	.27	.0050	.0002	.33	0.3
18462	Feb. 9	Slight.	Cons.	0.75	5.90	2.30	.0054	.0338	.0260	.0078	.77	.0070	.0001	.62	1.9
18634	Feb. 24	V. slight.	V. slight.	1.10	7.30	2.85	.0076	.0324	.0298	.0026	.76	.0080	.0000	.90	2.5
18729	Mar. 9	V. slight.	V. slight.	0.50	4.95	1.85	.0034	.0230	.0194	.0036	.68	.0070	.0001	.55	1.7
19019	Apr. 13	V. slight.	V. slight.	0.60	5.45	2.00	.0010	.0232	.0196	.0036	.69	.0100	.0002	.60	1.7
19217	May 11	V. slight.	Slight.	0.42	5.30	1.60	.0010	.0324	.0272	.0052	.72	.0070	.0001	.52	1.7
19410	June 8	V. slight.	Slight.	0.60	4.90	2.05	.0024	.0262	.0242	.0020	.64	.0050	.0001	.57	1.8
19776	July 13	Slight.	V. slight.	0.45	4.80	2.00	.0000	.0278	.0198	.0080	.64	.0020	.0000	.63	1.7
20056	Aug 10	Slight.	Slight.	0.39	4.65	1.85	.0006	.0228	.0176	.0052	.67	.0030	.0000	.52	1.7
20478	Sept. 14	V. slight.	Slight.	0.40	4.55	2.00	.0006	.0240	.0210	.0030	.67	.0000	.0000	.47	1.7
20786	Oct. 13	V. slight.	V. slight.	0.50	4.75	1.95	.0038	.0324	.0294	.0030	.67	.0050	.0002	.48	1.4
21220	Nov. 10	Slight.	Slight.	0.49	4.45	1.70	.0060	.0326	.0294	.0032	.72	.0050	.0002	.38	1.8
21567	Dec. 14	V. slight.	Cons.	0.52	4.15	1.75	.0048	.0312	.0292	.0020	.65	.0170	.0000	.46	2.0

Averages by Years.

–	1888	–	–	.33	3.48	1.40	.0026	.0287	–	–	.45	.0082	.0001	–	–
–	1889	–	–	.23	2.96	1.14	.0014	.0241	.0190	.0051	.41	.0048	.0001	–	–
–	1890	–	–	.36	3.57	1.35	.0013	.0227	.0179	.0048	.42	.0088	.0001	–	1.0
–	1891	–	–	.42	3.26	1.30	.0005	.0241	.0183	.0058	.40	.0065	.0001	–	0.7
–	1892	–	–	.48	3.73	1.56	.0016	.0299	.0227	.0072	.47	.0092	.0001	–	1.0
–	1893	–	–	.75	4.21	1.63	.0052	.0299	.0218	.0081	.51	.0059	.0001	.53	1.0
–	1894	–	–	.75	4.47	1.88	.0053	.0292	.0242	.0050	.57	.0076	.0001	.63	1.1
–	1895	–	–	.60	5.05	2.12	.0031	.0294	.0222	.0072	.70	.0063	.0001	.62	1.4
–	1896	–	–	.45	4.22	1.65	.0018	.0243	.0208	.0035	.58	.0047	.0001	.55	1.1
–	1897*	–	–	.50	4.79	1.86	.0029	.0268	.0229	.0039	.65	.0061	.0001	.52	1.6

* Where more than one sample was collected in a month, the mean analysis for that month has been used in making the average.

NOTE to analyses of 1897: Odor, generally distinctly vegetable, occasionally mouldy and unpleasant. —— The samples were collected from the pond, near the gate-house, about 1 foot beneath the surface. For monthly record of height of water in this pond, see page 225.

LYNN.

Microscopical Examination of Water from Birch Pond, Lynn.

[Number of organisms per cubic centimeter.]

	1897.												
	Jan.	Feb.	Feb.	Mar	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
Day of examination,	19	10	26	11	15	12	11	16	12	15	14	12	16
Number of sample,	18269	18462	18634	18729	19019	19217	19410	19776	20056	20478	20786	21220	21567
PLANTS.													
Diatomaceæ,	390	72	124	52	20	484	6	222	973	1,710	238	18	42
Asterionella,	0	8	0	0	2	12	0	2	76	1,700	112	9	17
Synedra,	388	60	124	52	18	444	0	12	8	2	10	2	2
Tabellaria,	2	0	0	0	0	28	3	208	888	4	116	4	19
Cyanophyceæ, Anabæna,	0	0	0	0	0	0	0	0	18	0	20	0	0
Algæ,	0	28	4	4	0	1	0	6	7	12	34	22	5
ANIMALS.													
Rhizopoda,	0	0	0	0	0	0	1	0	0	0	2	1	0
Infusoria,	3	15	50	32	147	404	0	160	84	88	688	1	23
Cryptomonas,	0	0	10	0	0	0	0	0	0	0	0	0	0
Dinobryon,	0	2	0	0	130	400	0	18	80	76	688	0	0
Euglena,	0	4	12	8	0	0	0	0	0	4	0	0	0
Peridinium,	0	7	28	22	4	1	0	124	2	0	0	0	21
Trachelomonas,	3	0	0	0	2	0	0	16	2	6	0	0	1
Vermes,	0	2	0	0	1	2	0	0	0	2	0	0	0
Crustacea, Cyclops,	pr.	0	0	0	0	0	0	0	pr.	0	0	pr.	0
Miscellaneous, Zoöglœa,	80	0	20	30	60	40	5	25	30	0	10	5	5
TOTAL,	473	117	198	118	228	931	12	413	1,112	1,812	992	47	75

Chemical Examination of Water from Walden Pond, Lynn.

[Parts per 100,000.]

Number.	Date of Collection.	Appearance.			Residue on Evaporation.		Ammonia.				Chlorine.	Nitrogen as		Oxygen Consumed.	Hardness.
								Albuminoid.							
		Turbidity.	Sediment.	Color.	Total.	Loss on Ignition.	Free.	Total.	Dissolved.	Sus-pended.		Nitrates.	Nitrites.		
	1897.														
18272	Jan. 18	Slight.	Slight.	0.48	4.95	2.10	.0046	.0368	.0340	.0028	.53	.0080	.0001	.64	0.9
18464	Feb. 9	Slight.	V. slight.	0.90	4.20	1.75	.0042	.0180	.0150	.0030	.55	.0050	.0000	.60	0.9
18638	Feb. 24	V. slight.	V. slight.	0.65	4.05	1.90	.0002	.0242	.0164	.0078	.53	.0000	.0000	.68	0.5
18731	Mar. 9	V. slight.	V. slight.	0.43	3.60	1.25	.0004	.0178	.0122	.0056	.44	.0030	.0000	.47	0.6
19021	Apr. 13	Slight.	Slight.	0.48	3.35	1.35	.0026	.0192	.0156	.0036	.41	.0030	.0001	.49	0.5
19219	May 11	V. slight.	V. slight.	0.40	3.40	1.35	.0016	.0236	.0186	.0050	.43	.0000	.0000	.50	0.6
19412	June 8	V. slight.	Slight.	0.80	3.05	1.50	.0148	.0298	.0248	.0050	.36	.0030	.0000	.62	0.3
19778	July 13	V. slight.	Slight.	0.63	3.40	1.20	.0040	.0490	.0188	.0302	.41	.0020	.0000	.66	0.5
20058	Aug. 10	Slight.	Slight.	0.72	3.90	1.80	.0006	.0280	.0220	.0060	.38	.0000	.0000	.66	0.8
20480	Sept. 14	Distinct.	Cons.	1.10	4.45	2.60	.0002	.0496	.0382	.0114	.47	.0000	.0000	.80	1.1
20787	Oct. 13	V. slight.	V. slight.	1.20	4.60	2.60	.0062	.0570	.0490	.0080	.44	.0030	.0001	.88	0.6
21221	Nov. 10	Distinct.	Cons.	1.22	4.70	2.70	.0072	.0520	.0512	.0008	.52	.0100	.0004	.88	1.7
21568	Dec. 14	Slight.	Cons.	1.02	4.80	2.35	.0040	.0424	.0384	.0040	.48	.0180	.0001	.82	1.1

Averages by Years.

–	1890	–	–	1.06	4.98	2.53	.0292	.0432	.0351	.0081	.34	.0057	.0001	–	1.1
–	1891	–	–	1.21	4.32	2.20	.0058	.0615	.0403	.0212	.34	.0091	.0001	–	0.7
–	1892	–	–	0.90	4.81	2.50	.0094	.0626	.0383	.0243	.41	.0116	.0001	–	0.6
–	1893	–	–	0.92	4.33	2.40	.0066	.0470	.0309	.0161	.44	.0047	.0001	.80	0.7
–	1896	–	–	0.68	3.45	1.57	.0031	.0296	.0255	.0041	.40	.0017	.0000	.76	0.5
–	1897*	–	–	0.77	4.03	1.88	.0040	.0355	.0282	.0073	.45	.0044	.0001	.67	0.8

* Where more than one sample was collected in a month, the mean analysis for that month has been used in making the average.

Note to analyses of 1897: Odor, generally distinctly vegetable and occasionally fishy or unpleasant. —— The samples were collected from the pond, near the gate-house, 1 foot beneath the surface. For monthly record of height of water in this pond, see page 225.

LYNN.

Microscopical Examination of Water from Walden Pond, Lynn.

[Number of organisms per cubic centimeter.]

	1897.												
	Jan.	Feb.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
Day of examination,	19	10	27	11	15	13	11	16	12	15	14	12	16
Number of sample,	18272	18464	18638	18731	19021	19219	19412	19778	20058	20480	20787	21221	21568
PLANTS.													
Diatomaceæ,	8	0	0	2	13	8	35	4	12	440	50	64	24
Asterionella,	0	0	0	0	1	4	0	4	0	272	0	1	0
Melosira,	8	0	0	0	8	0	0	0	0	104	0	0	0
Synedra,	0	0	0	2	4	3	28	0	4	22	24	60	6
Cyanophyceæ,	0	0	0	0	0	45	0	8	60	160	66	3	0
Clathrocystis,	0	0	0	0	0	0	0	5	38	0	44	0	0
Cœlosphærium,	0	0	0	0	0	0	0	3	16	156	20	3	0
Merismopœdia,	0	0	0	0	0	45	0	0	0	0	0	0	0
Algæ,	0	2	0	2	0	68	0	16	30	26	90	13	0
Raphidium,	0	0	0	0	0	58	0	0	0	10	30	0	0
ANIMALS.													
Infusoria,	1,575	9	676	60	147	1	1	2	14	38	48	6	14
Dinobryon,	1,492	2	0	14	136	0	0	0	0	28	0	1	0
Peridinium,	80	6	652	40	0	0	0	0	0	0	0	0	12
Trachelomonas,	1	0	12	2	0	1	0	2	12	2	48	5	1
Uroglena,	0	0	0	0	9	0	0	0	0	0	0	0	0
Vermes,	0	1	0	0	0	0	0	2	0	14	4	1	0
Crustacea,	0	0	0	0	pr.	0	0	0	0	0	0	pr.	pr.
Miscellaneous, Zoöglœa,	40	15	0	5	40	0	15	15	40	10	10	5	5
TOTAL,	1,623	27	676	69	200	122	51	47	156	688	268	92	43

Chemical Examination of Water from Glen Lewis Pond, Lynn.

[Parts per 100,000.]

Number.	Date of Collection.	Appearance.			Residue on Evaporation.		Ammonia.				Chlorine.	Nitrogen as		Oxygen Consumed.	Hardness.
								Albuminoid.							
		Turbidity.	Sediment.	Color.	Total.	Loss on Ignition.	Free.	Total.	Dissolved.	Sus-pended.		Nitrates.	Nitrites.		
	1897.														
21224	Nov. 10	Slight.	Cons.	.44	3.90	2.30	.0090	.0540	.0468	.0072	.49	.0180	.0003	.59	1.0
21571	Dec. 14	Decided.	Cons.	.40	3.70	2.10	.0078	.0380	.0300	.0080	.49	.0070	.0003	.58	0.8

Chemical Examination of Water from Glen Lewis Pond, Lynn — Concluded.

Averages by Years.

[Parts per 100,000.]

Number.	Date of Collection.	Appearance.			Residue on Evaporation.		Ammonia.				Chlorine.	Nitrogen as		Oxygen Consumed.	Hardness.
		Turbidity.	Sediment.	Color.	Total.	Loss on Ignition.	Free.	Albuminoid. Total.	Albuminoid. Dissolved.	Albuminoid. Suspended.		Nitrates.	Nitrites.		
–	1890	–	–	.76	4.84	2.21	.0412	.0445	.0327	.0118	.36	.0063	.0001	–	1.0
–	1891	–	–	.63	3.90	1.75	.0328	.0484	.0324	.0160	.34	.0124	.0002	–	0.6
–	1892	–	–	.62	3.95	1.95	.0127	.0475	.0332	.0143	.40	.0193	.0002	–	0.6
–	1893	–	–	.64	3.81	2.14	.0112	.0729	.0329	.0400	.42	.0040	.0002	.60	0.6
–	1894	–	–	.85	3.81	1.89	.0107	.0495	.0297	.0198	.44	.0023	.0001	.69	0.5
–	1895	–	–	.42	3.77	1.65	.0053	.0381	.0246	.0135	.50	.0035	.0001	.54	0.7
–	1896	–	–	.36	3.74	1.91	.0068	.0567	.0306	.0261	.43	.0039	.0001	.47	0.4
–	1897	–	–	.42	3.80	2.20	.0084	.0460	.0384	.0076	.49	.0125	.0003	.58	0.9

NOTE to analyses of 1897: Odor of the first sample, faintly mouldy; of the last, distinctly vegetable, becoming also strongly fishy on heating. —— The samples were collected from the pond, near the gate-house, 1 foot beneath the surface. For monthly record of height of water in this pond, see page 225.

Microscopical Examination.

No. 21224. Diatomaceæ, *Asterionella*, 3; *Cyclotella*, 6; *Melosira*, 8; *Meridion*, 4; *Navicula*, 3; *Synedra*, 6; *Tabellaria*, 4. Cyanophyceæ, *Cœlosphærium*, 4. Algæ, *Botryococcus*, 10; *Pediastrum*, 1; *Scenedesmus*, 1. Infusoria, *Dinobryon*, 1; *Trachelomonas*, 1. Vermes, *Asplanchna*, 1. Miscellaneous, *Zoöglœa*, 5. Total, 58.

No. 21571. Diatomaceæ, *Cyclotella*, 2; *Cymbella*, 3; *Synedra*, 4; *Tabellaria*, 7. Cyanophyceæ, *Cœlosphærium*, 1. Algæ, *Closterium*, 1; *Cosmarium*, 2; *Sphærozosma*, 3; *Zoöspores*, 2. Rhizopoda, *Actinophrys*, 1. Infusoria, *Dinobryon*, 15; *Peridinium*, 68; *Trachelomonas*, 2. Vermes, *Anurea*, 1; *Asplanchna*, 1. Miscellaneous, *Zoöglœa*, 5. Total, 118.

Chemical Examination of Water from Hawkes Pond, Lynn.

[Parts per 100,000.]

Number.	Date of Collection.	Appearance.			Residue on Evaporation.		Ammonia.				Chlorine.	Nitrogen as		Oxygen Consumed.	Hardness.
		Turbidity.	Sediment.	Color.	Total.	Loss on Ignition.	Free.	Albuminoid. Total.	Albuminoid. Dissolved.	Albuminoid. Suspended.		Nitrates.	Nitrites.		
	1897.														
18273	Jan. 18	Slight.	Slight.	.75	5.80	2.30	.0012	.0186	.0186	.0000	.70	.0150	.0001	.81	1.7
18467	Feb. 9	Slight.	Slight.	.70	5.30	2.20	.0056	.0238	.0228	.0010	.69	.0180	.0003	.70	1.6
18640	Feb. 24	V. slight.	V. slight.	.55	4.90	1.85	.0040	.0236	.0230	.0006	.63	.0100	.0000	.58	1.6
18733	Mar. 9	Slight.	V. slight.	.60	4.45	1.45	.0010	.0214	.0166	.0048	.54	.0150	.0002	.51	1.3
19023	Apr. 13	V. slight.	V. slight.	.55	4.20	1.70	.0028	.0182	.0152	.0030	.49	.0150	.0002	.59	1.1
19221	May 11	V. slight.	V. slight.	.43	4.20	1.60	.0010	.0288	.0212	.0076	.52	.0080	.0001	.54	1.1
19414	June 8	None.	V. slight.	.73	3.90	1.60	.0050	.0236	.0218	.0018	.41	.0070	.0003	.64	1.4
19780	July 13	V. slight.	V. slight.	.51	4.45	1.75	.0034	.0232	.0198	.0034	.42	.0030	.0003	.70	1.4
20060	Aug. 10	V. slight	V. slight.	.43	4.20	1.60	.0012	.0224	.0176	.0048	.46	.0050	.0001	.61	1.4
20481	Sept. 14	V. slight.	Slight.	.32	4.30	1.80	.0000	.0294	.0230	.0064	.50	.0020	.0000	.51	1.7
20788	Oct. 13	V. slight.	V. slight.	.30	4.20	1.80	.0018	.0250	.0250	.0000	.49	.0030	.0001	.38	1.4
21222	Nov. 10	Decided.	Cons.	.39	5.15	2.15	.0034	.0328	.0226	.0102	.62	.0130	.0002	.45	2.6
21569	Dec. 14	Slight.	Cons.	.88	5.75	2.40	.0034	.0228	.0200	.0028	.61	.0180	.0001	.73	2.7
Av.*.	....	....	....	.54	4.64	1.85	.0024	.0242	.0204	.0038	.53	.0098	.0001	.59	1.6

* Where more than one sample was collected in a month, the mean analysis for that month has been used in making the average.

Odor, generally distinctly vegetable, sometimes mouldy. —— The samples were collected from the pond. For monthly record of height of water in this pond, see page 225.

LYNN.

Microscopical Examination of Water from Hawkes Pond, Lynn.

[Number of organisms per cubic centimeter.]

	1897.												
	Jan.	Feb.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
Day of examination, . . .	19	10	27	11	15	13	11	16	12	15	14	12	16
Number of sample, . . .	18273	18467	18640	18733	19023	19221	19414	19780	20060	20481	20788	21222	21569
PLANTS.													
Diatomaceæ, . . .	54	2	3	20	8	60	954	74	5	84	6	4	5
Synedra, ...	54	2	3	12	2	56	4	70	4	78	1	1	1
Tabellaria, ...	0	0	0	0	0	2	924	4	0	0	2	0	4
Algæ, ...	0	0	4	0	0	1	4	2	148	16	0	0	0
Protococcus, . . .	0	0	0	0	0	1	0	2	148	16	0	0	0
ANIMALS.													
Rhizopoda, ...	0	0	0	2	0	0	1	0	0	0	0	0	0
Infusoria, ...	35	1	4	2	3	0	3	1	4	4	2	61	7
Dinobryon, ...	35	0	0	0	0	0	0	0	0	0	0	57	3
Vermes, ...	0	0	5	2	0	0	1	0	0	0	0	1	1
Crustacea, Daphnia, . .	0	0	0	0	0	pr.	0	0	0	0	0	0	0
Miscellaneous, Zoöglœa, . .	15	5	20	25	10	0	10	60	10	8	5	100	5
TOTAL, ...	104	8	36	51	21	61	973	137	167	112	13	166	18

Chemical Examination of Water from the Wakefield Branch of Saugus River.

[Parts per 100,000.]

Number.	Date of Collection.	Appearance.			Residue on Evaporation.		Ammonia.				Chlorine.	Nitrogen as		Oxygen Consumed.	Hardness.
		Turbidity.	Sediment.	Color.	Total.	Loss on Ignition.	Free.	Albuminoid. Total.	Albuminoid. Dissolved.	Albuminoid. Suspended.		Nitrates.	Nitrites.		
18643	1897. Feb. 24	Distinct.	Slight.	.72	8.70	2.70	.0256	.0238	.0236	.0002	1.15	.0500	.0010	.64	2.9

Odor, distinctly vegetable and mouldy. —— The sample was collected from the Wakefield branch, near its junction with the Saugus River.

LYNN.

Chemical Examination of Water from the Saugus River at the Line between Saugus and Wakefield, and just above the Point where it is joined by the Branch from Wakefield Centre.

[Parts per 100,000.]

Number.	Date of Collection.	Appearance.			Residue on Evaporation.		Ammonia.				Chlorine.	Nitrogen as		Oxygen Consumed.	Hardness.
		Turbidity.	Sediment.	Color.	Total.	Loss on Ignition.	Free.	Albuminoid. Total.	Albuminoid. Dissolved.	Albuminoid. Sus-pended.		Nitrates.	Nitrites.		
	1897.														
18274	Jan. 18	Slight.	Slight.	1.50	10.40	4.50	.0006	.0452	.0424	.0028	.86	.0000	.0002	1.36	3.1
18466	Feb. 9	Slight.	Cons.	1.10	6.55	2.95	.0004	.0278	.0270	.0008	.73	.0030	.0001	0.67	2.2
18642	Feb. 24	V. slight.	Slight.	1.20	7.50	3.05	.0020	.0292	.0276	.0016	.77	.0000	.0000	1.02	3.0
18734	Mar. 9	V. slight.	Slight.	0.90	5.45	2.50	.0006	.0238	.0228	.0010	.53	.0030	.0000	0.74	2.1
19024	Apr. 13	V. slight.	Cons.	1.20	5.60	2.60	.0006	.0336	.0314	.0022	.57	.0030	.0001	0.94	1.8
19222	May 11	V. slight.	V. slight.	1.40	6.45	2.95	.0018	.0380	.0380	.0000	.65	.0030	.0000	1.28	2.1
19415	June 8	None.	Slight.	1.30	6.45	3.15	.0008	.0392	.0392	.0000	.49	.0030	.0000	1.06	2.7
19781	July 13	V. slight.	V. slight.	1.95	10.50	4.65	.0030	.0486	.0466	.0020	.72	.0020	.0003	2.35	4.3
20061	Aug. 10	V. slight.	V. slight.	1.50	8.20	3.60	.0020	.0440	.0420	.0020	.62	.0020	.0000	1.70	3.4
20483	Sept. 14	V. slight.	Slight.	0.88	7.95	3.30	.0018	.0316	.0314	.0002	.77	.0020	.0001	0.81	3.6
20790	Oct. 13	V. slight.	V. slight.	0.95	7.55	2.90	.0018	.0318	.0310	.0008	.72	.0020	.0001	0.82	3.6
21225	Nov. 10	V. slight.	Cons.	1.27	8.85	4.00	.0034	.0402	.0372	.0030	.88	.0130	00001	1.18	3.8
21572	Dec. 14	Slight.	Slight.	1.10	6.95	2.90	.0028	.0328	.0308	.0020	.56	.0100	.0002	0.98	2.9

Averages by Years.

-	1894	-	-	1.18	7.71	3.00	.0017	.0287	.0260	.0027	.62	.0038	.0000	1.01	3.2
-	1895	-	-	1.39	7.70	3.37	.0024	.0359	.0336	.0023	.71	.0043	.0001	1.43	3.2
-	1896	-	-	1.19	7.47	3.29	.0022	.0371	.0322	.0049	.60	.0032	.0001	1.27	2.8
-	1897*	-	-	1.26	7.61	3.34	.0017	.0364	.0350	.0014	.68	.0037	.0001	1.17	3.0

* Where more than one sample was collected in a month, the mean analysis for that month has been used in making the average.

Note to analyses of 1897: Odor, distinctly vegetable and occasionally mouldy; in January, fishy. —— The samples were collected from the Saugus River, at a road crossing above Howlett's Pond, just above the point where the river is joined by the branch from Wakefield Centre.

LYNN.

Chemical Examination of Water from the Saugus River at Howlett's Dam, Saugus.

[Parts per 100,000.]

Number.	Date of Collection.	Appearance.			Residue on Evaporation.		Ammonia.				Chlorine.	Nitrogen as		Oxygen Consumed.	Hardness.
								Albuminoid.							
		Turbidity.	Sediment.	Color.	Total.	Loss on Ignition.	Free.	Total.	Dissolved.	Suspended.		Nitrates.	Nitrites.		
	1897.														
18271	Jan. 18	Slight.	V. slight.	1.40	9.70	4.00	.0008	.0408	.0404	.0004	0.88	.0150	.0001	1.28	3.2
18465	Feb. 9	V. slight.	Slight.	0.70	5.75	2.05	.0064	.0250	.0222	.0028	0.78	.0080	.0001	0.56	1.7
18644	Feb. 24	Slight.	V. slight.	1.10	8.00	3.20	.0148	.0274	.0274	.0000	0.85	.0230	.0002	0.88	3.1
18732	Mar. 9	V. slight.	V. slight.	0.88	5.65	2.00	.0044	.0266	.0250	.0016	0.60	.0150	.0002	0.67	1.9
19022	Apr. 13	V. slight.	V. slight.	1.10	6.25	2.55	.0014	.0314	.0314	.0000	0.73	.0130	.0002	0.92	1.9
19220	May 11	Slight.	V. slight.	1.30	7.10	3.05	.0024	.0340	.0340	.0000	0.76	.0070	.0003	1.17	2.3
19413	June 8	V. slight.	V. slight.	1.40	7.00	3.30	.0036	.0380	.0346	.0034	0.69	.0070	.0002	1.12	2.6
19779	July 13	V. slight.	Slight.	1.75	10.55	4.05	.0030	.0290	.0276	.0014	0.98	.0020	.0000	2.10	4.3
20059	Aug. 10	Slight.	V. slight.	1.20	8.15	3.60	.0044	.0428	.0368	.0060	0.60	.0000	.0000	1.27	3.2
20482	Sept. 14	V. slight.	V. slight.	0.60	6.95	3.00	.0056	.0340	.0328	.0012	0.90	.0000	.0000	0.66	3.1
20789	Oct. 13	V. slight.	V. slight.	0.63	8.95	3.00	.0032	.0336	.0330	.0006	1.26	.0050	.0003	0.68	5.3
21223	Nov. 10	Slight.	Slight.	0.89	8.00	3.10	.0110	.0360	.0336	.0024	0.97	.0150	.0008	0.62	3.5
21570	Dec. 14	Decided.	Cons.	1.02	7.75	2.65	.0094	.0322	.0258	.0064	0.96	.0380	.0006	0.84	3.5

Averages by Years.

-	1894	-	-	1.16	8.68	3.36	.0056	.0310	.0272	.0038	1.03	.0112	.0014	0.95	3.5
-	1895	-	-	1.29	8.33	3.62	.0064	.0381	.0349	.0032	0.94	.0125	.0003	1.31	3.1
-	1896	-	-	0.94	7.50	2.92	.0058	.0343	.0304	.0039	0.86	.0163	.0004	0.93	2.7
-	1897*	-	-	1.09	7.74	3.08	.0050	.0337	.0317	.0020	0.84	.0110	.0002	1.00	3.1

* Where more than one sample was collected in a month, the mean analysis for that month has been used in making the average.

NOTE to analyses of 1897: Odor, distinctly vegetable and mouldy or musty. —— The samples were collected from the river, at Howlett's Dam.

LYNN.

Chemical Examination of Water from a Faucet in Lynn supplied from the Lynn Water Works.

[Parts per 100,000.]

Number.	Date of Collection.	Appearance.			Residue on Evaporation.		Ammonia.				Chlorine.	Nitrogen as		Oxygen Consumed.	Hardness.
								Albuminoid.							
		Turbidity.	Sediment.	Color.	Total.	Loss on Ignition.	Free.	Total.	Dissolved.	Sus-pended.		Nitrates.	Nitrites.		
	1897.														
18275	Jan. 18	V. slight.	V. slight.	.47	5.55	2.05	.0006	.0220	.0204	.0016	.53	.0120	.0002	.55	1.6
18504	Feb. 15	V. slight.	V. slight.	.60	4.30	1.60	.0034	.0194	.0194	.0000	.70	.0100	.0001	.57	1.3
18645	Feb. 24	V slight.	V. slight.	.75	5.80	2.40	.0026	.0224	.0204	.0020	.72	.0120	.0000	.69	3.1
18735	Mar. 9	V. slight.	Slight.	.65	5.10	1.85	.0012	.0192	.0184	.0008	.71	.0080	.0000	.55	1.7
19025	Apr. 13	V slight.	Cons.	.53	5.40	1.65	.0006	.0180	.0180	.0000	.63	.0120	.0001	.56	1.7
19223	May 11	V. slight.	V. slight.	.68	5.05	1.80	.0000	.0224	.0176	.0048	.68	.0080	.0000	.63	1.9
19416	June 8	V. slight.	Cons.	.70	7.00	2.10	.0012	.0240	.0210	.0030	.60	.0070	.0000	.49	2.3
19782	July 13	V. slight.	V. slight.	.62	4.00	1.30	.0014	.0190	.0164	.0026	.42	.0050	.0001	.59	1.3
20062	Aug. 10	Slight.	Slight.	.51	4.35	1.60	.0006	.0238	.0160	.0078	.48	.0030	.0000	.49	1.6
20484	Sept. 14	V. slight	V. slight.	.32	4.10	1.85	.0004	.0170	.0136	.0034	.49	.0020	.0000	.42	1.7
20791	Oct. 13	V. slight.	V. slight.	.32	4.10	1.35	.0008	.0182	.0162	.0020	.52	.0030	.0001	.37	2.3
21226	Nov. 10	Slight.	Cons.	.39	4.55	1.60	.0020	.0188	.0170	.0018	.70	.0090	.0001	.31	2.0
21573	Dec. 14	Slight.	Slight.	.48	4.35	1.90	.0026	.0242	.0210	.0032	.64	.0150	.0001	.56	1.7

Averages by Years.

–	1894	–	–	.76	4.60	1.95	.0023	.0216	.0194	.0022	.57	.0065	.0001	.62	1.3
–	1895	–	–	.78	5.12	2.14	.0017	.0225	.0195	.0030	.65	.0102	.0001	.84	1.7
–	1896	–	–	.54	4.41	1.79	.0015	.0217	.0179	.0038	.51	.0063	.0001	.58	1.3
–	1897*	–	–	.53	4.88	1.75	.0012	.0206	.0179	.0027	.59	.0079	.0001	.51	1.8

* Where more than one sample was collected in a month, the mean analysis for that month has been used in making the average.

NOTE to analyses of 1897: Odor, generally distinctly vegetable; in January and December, fishy. —— The samples were collected from a faucet in the city.

Table showing Monthly Depth of Water in Feet in the Ponds and Storage Reservoirs of the Lynn Water Works during the Year 1897.

Date.	Breed's Pond. High Water, 21.50 Feet.	Birch Pond. High Water, 21.50 Feet.*	Walden Pond. High Water, 17.00 Feet.	Glen Lewis Pond. High Water, 17.00 Feet.*	Hawkes Pond. High Water, 25.00 Feet.
1897.					
Jan. 1,	18.87	10.00	–	11.17	12.50
Feb. 1,	19.29	13.42	6.67	–	15.37
March 1,	18.21	20.08	7.71	–	15.58
April 1,	20.92	21.92	12.17	–	23.17
May 1,	21.00	22.50	13.92	–	24.96
June 1,	21.67	22.33	14.75	–	24.92
July 1,	20.92	22.71	15.75	–	24.83
Aug. 1,	20.00	22.33	12.00	–	24.83
Sept. 1,	19.08	21.67	9.17	12.83	24.25
Oct. 1,	17.75	20.92	9.00	13.00	16.00
Nov. 1,	16.42	20.12	8.50	12.75	6.00
Dec. 1,	17.83	17.33	9.83	14.25	9.83

* The water in these ponds is sometimes raised above ordinary high water.

MALDEN, MEDFORD AND MELROSE.

WATER SUPPLY OF MALDEN, MEDFORD AND MELROSE.

Chemical Examination of Water from Spot Pond, Stoneham.

[Parts per 100,000.]

Number.	Date of Collection.	Appearance.			Residue on Evaporation.		Ammonia.				Chlorine.	Nitrogen as		Oxygen Consumed.	Hardness.
		Turbidity.	Sediment.	Color.	Total.	Loss on Ignition.	Free.	Albuminoid. Total.	Albuminoid. Dissolved.	Albuminoid. Suspended.		Nitrates.	Nitrites.		
	1897.														
18245	Jan. 12	Slight.	Slight.	.37	6.10	2.60	.0012	.0268	.0240	.0028	.58	.0030	.0001	.38	1.9
18436	Feb. 2	V. slight.	V. slight.	.33	5.25	2.00	.0010	.0200	.0162	.0038	.62	.0050	.0000	.34	2.3
18707	Mar. 3	V. slight.	V. slight.	.35	5.40	1.65	.0018	.0236	.0232	.0004	.63	.0050	.0002	.50	2.6
18969	April 6	Slight.	Slight.	.40	4.80	1.55	.0028	.0250	.0166	.0084	.52	.0070	.0001	.46	1.8
19213	May 11	Slight.	Slight.	.35	4.55	1.50	.0006	.0192	.0134	.0058	.58	.0030	.0000	.43	2.1
19370	June 2	V. slight.	Slight.	.35	5.00	2.00	.0044	.0328	.0302	.0026	.50	.0030	.0000	.47	2.2
19753	July 8	Slight.	Slight.	.42	4.65	1.30	.0010	.0300	.0274	.0026	.48	.0020	.0000	.61	1.4
19992	Aug. 3	Slight.	V. slight.	.34	4.65	1.95	.0014	.0326	.0272	.0054	.58	.0020	.0000	.56	1.6
20377	Sept. 6	Slight.	Slight.	.32	5.10	1.90	.0018	.0334	.0282	.0052	.61	.0000	.0000	.52	1.6
20742	Oct. 7	V. slight.	V. slight.	.38	4.95	2.10	.0008	.0282	.0244	.0038	.56	.0020	.0001	.48	2.2
21057	Nov. 5	V. slight.	Slight.	.32	5.50	2.60	.0048	.0300	.0272	.0028	.58	.0030	.0001	.46	2.0
21483	Dec. 8	Slight.	Slight.	.35	5.35	2.05	.0038	.0260	.0238	.0022	.58	.0050	.0001	.44	2.3

Averages by Years.

-	1888	-	-	.22	3.98	1.24	.0007	.0225	-	-	.44	.0054	.0001	-	-
-	1889	-	-	.26	3.54	1.17	.0017	.0236	.0198	.0038	.44	.0053	.0002	-	-
-	1890	-	-	.22	3.96	1.24	.0022	.0223	.0182	.0041	.43	.0078	.0001	-	1.7
-	1891	-	-	.21	3.70	1.27	.0008	.0183	.0161	.0022	.43	.0082	.0001	-	1.4
-	1892	-	-	.17	4.28	1.30	.0035	.0198	.0157	.0041	.50	.0081	.0001	-	1.7
-	1893	-	-	.29	5.70	1.71	.0085	.0197	.0162	.0035	.49	.0105	.0003	.33	2.4
-	1894	-	-	.23	5.90	1.68	.0029	.0210	.0160	.0050	.57	.0039	.0001	.36	2.4
-	1895	-	-	.25	5.92	2.02	.0058	.0219	.0196	.0023	.61	.0096	.0000	.44	2.4
-	1896	-	-	.36	5.31	1.98	.0080	.0248	.0214	.0034	.57	.0047	.0001	.51	2.0
-	1897	-	-	.36	5.11	1.93	.0021	.0273	.0235	.0038	.57	.0033	.0001	.47	2.0

NOTE to analyses of 1897: Odor, generally distinctly vegetable, occasionally mouldy.——No. 18969 was collected from a faucet at the Spot Pond pumping station in Melrose; the other samples, from the pond. For monthly record of height of water in this pond, see page 227.

MALDEN, MEDFORD AND MELROSE.

Microscopical Examination of Water from Spot Pond, Stoneham.

[Number of organisms per cubic centimeter.]

	1897.											
	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
Day of examination,	13	9	6	7	12	4	10	4	7	11	8	9
Number of sample,	18245	18436	18707	18969	19213	19370	19753	19992	20377	20742	21057	21483
PLANTS.												
Diatomaceæ,	46	105	18	18	2,480	180	108	176	42	110	986	1,152
Asterionella,	4	80	17	8	2,460	0	0	24	36	12	264	140
Cyclotella,	0	1	0	2	0	176	12	2	2	6	28	88
Tabellaria,	30	16	1	8	8	4	96	148	0	46	672	896
Cyanophyceæ,	0	0	0	0	0	6	18	40	38	10	6	2
Anabæna,	0	0	0	0	0	0	2	34	18	0	2	0
Cœlosphærium,	0	0	0	0	0	0	10	4	20	10	4	2
Algæ,	10	0	1	0	2	12	384	546	188	12	1	10
Protococcus,	0	0	0	0	2	8	384	544	184	10	0	10
ANIMALS.												
Rhizopoda,	0	0	0	0	0	0	0	2	0	0	0	2
Infusoria,	4	1	4	2	11	5	3	6	17	50	2	12
Dinobryon,	0	0	1	0	0	1	0	0	17	26	0	0
Trachelomonas,	0	0	1	1	0	3	0	0	0	20	2	2
Vermes,	0	0	0	1	1	1	4	2	0	0	0	0
Crustacea, Cyclops,	0	0	pr.	0	0	0	0	0	0	0	0	0
Miscellaneous, Zoöglœa,	20	40	10	15	0	20	10	8	5	5	0	10
TOTAL,	80	146	33	36	2,494	224	527	780	290	187	995	1,188

Table showing Heights of Water in Spot Pond on the First of Each Month in 1897.

[NOTE. — Heights are in feet below the crest of the dam.]

DATE.	Height of Water.	DATE.	Height of Water.
1897.	Feet.	1897.	Feet.
Jan. 1,	5.48	July 1,	2.58
Feb. 1,	5.77	Aug. 1,	3.87
March 1,	5.58	Sept. 1,	5.25
April 1,	3.77	Oct. 1,	6.89
May 1,	3.17	Nov. 1,	8.69
June 1,	2.98	Dec. 1,	8.00

MALDEN.

Water Supply of Malden.

Chemical Examination of Water from the Tubular Wells at Maplewood (Webster Park), Malden.

[Parts per 100,000.]

Number.	Date of Collection.	Appearance.			Residue on Evaporation.	Ammonia.		Chlorine.	Nitrogen as		Oxygen Consumed.	Hardness.	Iron.
		Turbidity.	Sediment.	Color.		Free.	Albuminoid.		Nitrates.	Nitrites.			
	1897.												
18246	Jan. 12	None.	None.	.00	33.00	.0004	.0030	2.70	.4600	.0000	.00	17.0	.0070
18437	Feb. 2	None.	None.	.00	30.00	.0000	.0012	2.86	.4500	.0000	.00	16.0	.0000
18708	Mar. 3	None.	None.	.00	30.50	.0006	.0034	2.60	.5000	.0000	.07	18.0	.0000
18970	Apr. 5	None.	None.	.00	29.60	.0006	.0032	3.10	.4400	.0000	.05	15.0	.0030
19197	May 10	None.	None.	.00	28.60	.0002	.0018	2.76	.4100	.0000	.00	15.5	.0000
19371	June 2	None.	None.	.00	32.00	.0006	.0038	2.61	.4250	.0000	.02	17.0	.0000
19754	July 8	None.	None.	.00	30.50	.0000	.0054	3.00	.3600	.0000	.04	16.3	.0000
19991	Aug. 3	None.	None.	.00	28.80	.0006	.0032	2.93	.4750	.0000	.02	15.0	.0000
20378	Sept. 6	None.	None.	.00	28.40	.0000	.0018	2.90	.3500	.0000	.04	14.5	.0000
20743	Oct. 7	None.	None.	.02	27.90	.0002	.0040	2.90	.3500	.0000	.03	10.8	.0000
21058	Nov. 6	None.	V. slight.	.02	28.50	.0008	.0044	3.04	.8800	.0001	.03	14.5	.0010
21484	Dec. 8	None.	None.	.00	29.00	.0008	.0032	3.02	.4600	.0000	.04	16.5	.0010

Averages by Years.

-	1888	-	-	.00	17.45	.0000	.0003	2.30	.5081	-	-	-	-
-	1890	-	-	.00	18.19	.0002	.0014	2.29	.4952	.0001	-	8.0	-
-	1891	-	-	.00	20.83	.0001	.0007	2.23	.5146	.0001	-	9.6	-
-	1892	-	-	.00	23.00	.0000	.0005	2.36	.5129	.0000	-	11.4	.0335
-	1893	-	-	.00	23.72	.0001	.0011	2.48	.4823	.0000	.02	11.1	.0121
-	1894	-	-	.00	28.23	.0000	.0012	2.74	.3946	.0000	.02	13.2	.0058
-	1895	-	-	.00	32.02	.0001	.0015	2.73	.4317	.0000	.03	14.9	.0092
-	1896	-	-	.00	30.45	.0002	.0021	2.86	.4458	.0000	.04	13.7	.0090
-	1897	-	-	.00	29.73	.0004	.0032	2.87	.4633	.0000	.03	15.5	.0010

Note to analyses of 1897: Odor, none. —— The samples were collected from a faucet at the pumping station.

Water Supply of Manchester.

Chemical Examination of Water from the Well of the Manchester Water Works.

[Parts per 100,000.]

Number.	Date of Collection.	Appearance.			Residue on Evaporation.	Ammonia.		Chlorine.	Nitrogen as		Oxygen Consumed.	Hardness.	Iron.
		Turbidity.	Sediment.	Color.		Free.	Albu-minoid.		Nitrates.	Nitrites.			
	1897.												
18440	Feb. 8	None.	None.	.02	10.60	.0006	.0026	1.99	.0980	.0000	.00	3.0	.0050
19198	May 10	None.	V. slight.	.00	11.10	.0000	.0002	2.06	.1020	.0000	.00	4.3	.0000
20134	Aug. 16	None.	None.	.00	11.60	.0006	.0010	1.95	.0780	.0000	.01	3.9	.0000
21235	Nov. 15	None.	None.	.02	11.70	.0004	.0018	1.92	.1400	.0000	.01	4.6	.0020
Av...	....	....	....	.01	11.00	.0004	.0014	1.98	.1045	.0000	.00	3.9	.0017

Odor, none. A faintly vegetable odor was developed in two of the samples on heating.—The samples were collected from the well.

Water Supply of Mansfield Water Supply District, Mansfield.

Chemical Examination of Water from the Well of the Mansfield Water Works.

[Parts per 100,000.]

Number.	Date of Collection.	Appearance.			Residue on Evaporation.	Ammonia.		Chlorine.	Nitrogen as		Oxygen Consumed.	Hardness.	Iron.
		Turbidity.	Sediment.	Color.		Free.	Albu-minoid.		Nitrates.	Nitrites.			
	1897.												
19769	July 12	None.	None.	.00	2.50	.0010	.0024	.30	.0030	.0000	.00	0.6	.0040

Odor, none.—The sample was collected from a faucet at the pumping station.

MARBLEHEAD.

WATER SUPPLY OF MARBLEHEAD.

Chemical Examination of Water from Faucets in Marblehead supplied from the Marblehead Water Works.

[Parts per 100,000.]

Number.	Date of Collection.	Appearance.			Residue on Evaporation.	Ammonia.		Chlorine.	Nitrogen as		Oxygen Consumed.	Hardness.	Iron.
		Turbidity.	Sediment.	Color.		Free.	Albuminoid.		Nitrates.	Nitrites.			
	1897.												
18441	Feb. 8	Slight, milky.	V. slight.	.20	15.50	.0018	.0032	1.48	.0400	.0000	.02	5.1	.0550
19060	Apr. 15	Slight.	None.	.07	15.20	.0006	.0014	2.00	.0800	.0000	.03	7.3	.0230
19678	June 29	Slight.	None.	.02	14.90	.0024	.0012	1.60	.0250	.0001	.00	7.6	.0120
20016	Aug. 8	V. slight.	V. slight.	.12	15.80	.0032	.0024	1.42	.0180	.0000	.03	7.4	.0100
20688	Oct. 1	None.	V. slight.	.05	15.70	.0042	.0044	1.61	.0150	.0001	.02	7.9	.0060
Av...	....	....	....	.09	15.42	.0024	.0025	1.62	.0356	.0000	.02	7.1	.0212

Odor, none.

Chemical Examination of Water from Collecting Well No. 1 of the Marblehead Water Works.

[Parts per 100,000.]

Number.	Date of Collection.	Appearance.			Residue on Evaporation.	Ammonia.		Chlorine.	Nitrogen as		Oxygen Consumed.	Hardness.	Iron.
		Turbidity.	Sediment.	Color.		Free.	Albuminoid.		Nitrates.	Nitrites.			
	1897.												
19226	May 11	Distinct, milky.	Cons., rusty.	.50	15.60	.0272	.0026	1.88	.0250	.0002	.02	7.6	.0950
19721	July 6	Distinct.	Cons.	.58	16.10	.0114	.0054	2.00	.0260	.0001	.09	6.4	.0900

Odor, none. —— The samples were collected from well No. 1. These samples represent a mixture of water of collecting well No. 1 with water from collecting well No. 2 which flows into it.

Microscopical Examination.

No. 19226. Fungi, *Crenothrix*, 4,000.
No. 19721. Fungi, *Crenothrix*, 3,500.

MARBLEHEAD.

Chemical Examination of Water from Collecting Well No. 2 of the Marblehead Water Works.

[Parts per 100,000.]

Number.	Date of Collection.	Appearance.			Residue on Evaporation.	Ammonia.		Chlorine.	Nitrogen as		Oxygen Consumed.	Hardness.	Iron.
		Turbidity.	Sediment.	Color.		Free.	Albuminoid.		Nitrates.	Nitrites.			
	1897.												
19227	May 11	Decided, milky.	Cons., rusty.	1.30	17.40	.0122	.0032	1.51	.0030	.0000	.04	9.1	.3550
19722	July 6	Slight.	Slight.	0.20	16.70	.0008	.0074	1.78	.0030	.0000	.06	7.1	.0220

Odor, none. —— The samples were collected from the well.

Microscopical Examination.

No. 19227. Fungi, *Crenothrix*, 1,600.
No. 19722. No organisms.

Marion.

The advice of the State Board of Health to Joseph K. Nye, with reference to a proposed water supply for the towns of Wareham, Marion, Mattapoisett and Fairhaven, may be found on pages 47 to 49 of this volume. The results of analyses of samples of water from the proposed sources of supply may be found under Wareham and Fairhaven in this volume.

Water Supply of Marlborough.

Chemical Examination of Water from Lake Williams, Marlborough.

[Parts per 100,000.]

Number.	Date of Collection.	Appearance.			Residue on Evaporation.		Ammonia.				Chlorine.	Nitrogen as		Oxygen Consumed.	Hardness.
								Albuminoid.							
		Turbidity.	Sediment.	Color.	Total.	Loss on Ignition.	Free.	Total.	Dissolved.	Suspended.		Nitrates.	Nitrites.		
	1897.														
18447	Feb. 8	Distinct.	Slight.	.20	4.70	1.65	.0076	.0518	.0472	.0046	.52	.0130	.0001	.38	1.4
19210	May 10	Slight.	Slight.	.12	3.75	1.15	.0014	.0242	.0182	.0060	.46	.0100	.0000	.25	1.8
20020	Aug. 9	Slight.	Slight.	.13	4.35	1.50	.0008	.0216	.0186	.0030	.46	.0000	.0000	.28	1.7
21081	Nov. 8	Slight.	V. slight.	.14	4.20	1.55	.0006	.0222	.0222	.0000	.51	.0020	.0001	.22	2.0
Av...	....	....	....	.15	4.25	1.46	.0026	.0299	.0265	.0034	.49	.0062	.0000	.28	1.7

Odor of the first three samples, distinctly vegetable; of the last, none, becoming faintly earthy on heating. —— The first sample was collected from a faucet at the pumping station, and the other samples from the lake.

MARLBOROUGH.

Chemical Examination of Water from the North Branch of Millham Brook, near its Entrance to the Millham Brook Storage Reservoir, Marlborough.

[Parts per 100,000.]

Number.	Date of Collection.	Appearance.			Residue on Evaporation.		Ammonia.				Chlorine.	Nitrogen as		Oxygen Consumed.	Hardness.
		Turbidity.	Sediment.	Color.	Total.	Loss on Ignition.	Free.	Albuminoid. Total.	Albuminoid. Dissolved.	Albuminoid. Suspended.		Nitrates.	Nitrites.		
	1897.														
18277	Jan. 18	Slight.	Slight.	0.68	5.40	1.60	.0084	.0222	.0196	.0026	.36	.0100	.0002	0.64	0.9
18443	Feb. 8	Slight.	Slight.	0.70	3.95	1.65	.0044	.0264	.0208	.0056	.28	.0130	.0002	0.59	0.9
18713	Mar. 8	Slight.	Slight.	1.10	4.45	1.90	.0018	.0234	.0234	.0000	.28	.0170	.0000	0.85	1.1
18953	Apr. 5	V. slight.	V. slight.	1.20	4.35	1.65	.0004	.0216	.0204	.0012	.38	.0030	.0000	0.82	1.3
19206	May 10	None.	V. slight.	1.75	4.70	2.35	.0010	.0294	.0240	.0054	.34	.0150	.0000	1.17	1.1
19407	June 8	V. slight.	Slight.	1.90	5.60	2.90	.0024	.0334	.0324	.0010	.22	.0030	.0000	1.32	1.3
19762	July 12	V. slight.	Slight.	1.60	5.90	2.40	.0020	.0304	.0278	.0026	.34	.0020	.0001	1.09	1.3
20022	Aug. 9	None.	Slight.	2.90	7.60	4.15	.0018	.0474	.0414	.0060	.37	.0020	.0000	2.16	1.4
20457	Sept. 13	V. slight.	Slight.	1.55	6.10	2.75	.0002	.0308	.0294	.0014	.50	.0020	.0000	0.96	1.7
20753	Oct. 11	V. slight.	V. slight.	0.70	5.30	2.00	.0016	.0212	.0170	.0042	.50	.0020	.0000	0.20	1.4
21077	Nov. 8	V. slight.	V. slight.	2.20	8.65	4.25	.0014	.0386	.0386	.0000	.60	.0070	.0000	1.80	2.2
21504	Dec. 13	Slight.	Slight.	1.30	5.75	2.55	.0006	.0242	.0234	.0008	.44	.0150	.0002	0.98	1.8
Av..	1897	....	....	1.46	5.65	2.51	.0022	.0291	.0265	.0026	.38	.0076	.0001	1.05	1.4
Av..	1896	....	....	1.22	5.45	2.11	.0023	.0262	.0226	.0036	.35	.0095	.0001	1.09	1.4

NOTE to analyses of 1897: Odor, generally vegetable.

Chemical Examination of Water from Millham Brook, near its Entrance to the Millham Brook Storage Reservoir, Marlborough.

[Parts per 100,000.]

Number.	Date of Collection.	Appearance.			Residue on Evaporation.		Ammonia.				Chlorine.	Nitrogen as		Oxygen Consumed.	Hardness.
		Turbidity.	Sediment.	Color.	Total.	Loss on Ignition.	Free.	Albuminoid. Total.	Albuminoid. Dissolved.	Albuminoid. Suspended.		Nitrates.	Nitrites.		
	1897.														
18278	Jan. 18	Distinct.	Cons., dark.	0.60	5.45	2.00	.0016	.0280	.0244	.0036	.46	.0170	.0001	0.58	1.6
18444	Feb. 8	Slight.	Slight.	0.50	3.95	1.55	.0022	.0258	.0208	.0050	.28	.0200	.0001	0.56	1.1
18714	Mar. 8	Slight.	Slight.	0.55	4.40	1.50	.0010	.0158	.0158	.0000	.27	.0250	.0000	0.51	1.4
18952	Apr. 5	V. slight.	V. slight.	0.58	4.60	1.50	.0014	.0176	.0176	.0000	.38	.0250	.0002	0.51	1.6
19207	May 10	None.	V. slight.	1.00	4.50	1.60	.0032	.0268	.0190	.0078	.35	.0250	.0002	0.69	1.6
19406	June 8	None.	V. slight.	1.20	5.40	2.35	.0022	.0256	.0256	.0000	.20	.0080	.0001	0.83	1.8
19761	July 12	None.	V. slight.	0.47	5.60	1.95	.0038	.0176	.0170	.0006	.36	.0070	.0001	0.48	1.8
20021	Aug. 9	None.	V. slight.	1.20	6.35	2.70	.0020	.0236	.0236	.0000	.38	.0180	.0002	1.05	2.1
20458	Sept. 13	None.	V. slight.	0.46	5.80	2.10	.0008	.0186	.0182	.0004	.46	.0070	.0000	0.49	2.6
20754	Oct. 11	V. slight.	V. slight.	0.60	5.75	2.00	.0006	.0132	.0132	.0000	.46	.0030	.0000	0.50	2.6
21078	Nov. 8	None.	V. slight.	1.03	6.50	2.90	.0014	.0256	.0256	.0000	.51	.0160	.0000	1.01	3.3
21505	Dec. 13	V. slight.	Slight.	0.70	4.95	2.05	.0020	.0190	.0170	.0020	.40	.0230	.0002	0.57	2.1
Av..	1897	....	....	0.74	5.27	2.02	.0018	.0214	.0198	.0016	.38	.0162	.0001	0.65	2.0
Av..	1896	....	....	0.62	5.47	1.90	.0022	.0199	.0174	.0025	.37	.0209	.0001	0.65	1.9

NOTE to analyses of 1897: Odor, generally vegetable, becoming stronger and sometimes mouldy on heating. —— The samples were collected from the brook, near its entrance to Millham Brook Reservoir.

MARLBOROUGH.

Chemical Examination of Water from Millham Brook Storage Reservoir, Marlborough.

[Parts per 100,000.]

Number.	Date of Collection.	Appearance.			Residue on Evaporation.		Ammonia.				Chlorine.	Nitrogen as		Oxygen Consumed.	Hardness.
								Albuminoid.							
		Turbidity.	Sediment.	Color.	Total.	Loss on Ignition.	Free.	Total.	Dissolved.	Suspended.		Nitrates.	Nitrites.		
	1897.														
18279	Jan. 18	Slight.	Slight.	0.70	-	-	.0018	.0242	.0230	.0012	.40	.0170	.0001	.69	-
18445	Feb. 8	Slight.	V. slight.	0.60	4.50	1.80	.0102	.0262	.0238	.0024	.32	.0180	.0002	.52	1.3
18715	Mar. 8	Distinct.	Slight.	0.57	3.75	1.50	.0038	.0256	.0220	.0036	.22	.0150	.0000	.62	0.6
18954	Apr. 5	Slight.	Slight.	0.63	4.00	1.25	.0046	.0252	.0172	.0080	.30	.0170	.0001	.50	1.9
19208	May 10	Slight.	Slight.	0.65	3.35	1.00	.0016	.0286	.0196	.0090	.34	.0180	.0000	.54	0.9
19408	June 8	V. slight.	Slight.	0.90	3.75	1.60	.0022	.0298	.0252	.0046	.23	.0030	.0000	.61	1.3
19763	July 12	V. slight.	V. slight.	0.94	4.10	1.75	.0020	.0254	.0226	.0028	.25	.0020	.0000	.62	1.3
20023	Aug. 9	Distinct.	Slight.	0.92	4.45	2.05	.0008	.0310	.0250	.0060	.27	.0000	.0000	.73	1.3
20459	Sept. 13	Slight.	Slight.	0.90	4.70	2.20	.0008	.0330	.0224	.0106	.30	.0020	.0000	.75	1.6
20755	Oct. 11	V. slight.	V. slight.	1.20	4.75	2.25	.0010	.0380	.0322	.0058	.30	.0030	.0000	.76	1.7
21079	Nov. 8	V. slight.	Cons.	0.98	4.55	2.00	.0046	.0342	.0288	.0054	.35	.0030	.0001	.66	2.1
21506	Dec. 13	V. slight.	Slight.	0.99	4.75	2.05	.0042	.0308	.0298	.0010	.36	.0080	.0002	.63	2.1
Av...	1897	....	....	0.83	4.24	1.77	.0031	.0293	.0243	.0050	.30	.0088	.0001	.64	1.5
Av...	1896	....	....	0.80	4.44	1.68	.0058	.0306	.0248	.0058	.30	.0088	.0003	.69	1.3

NOTE to analyses of 1897: Odor, vegetable. The iron was determined in eleven samples, the average amount in parts per 100,000 being .0421.——The samples were collected from the reservoir, 2 feet beneath the surface.

Microscopical Examination of Water from Millham Brook Storage Reservoir, Marlborough.

[Number of organisms per cubic centimeter.]

	1897.											
	Jan.	Feb	Mar.	Apr.	May.	June.	July	Aug.	Sept.	Oct.	Nov.	Dec.
Day of examination,	19	9	9	6	12	11	15	11	14	12	11	14
Number of sample,	18279	18445	18715	18954	19208	19408	19763	20023	20459	20755	21079	21506
PLANTS.												
Diatomaceæ,	592	193	4	83	9,472	2,028	273	1,180	1,384	2,092	382	1,740
Asterionella,	592	192	0	81	9,472	2,028	0	144	1,380	504	364	1,736
Synedra,	0	1	4	2	0	0	1	132	4	36	4	4
Tabellaria,	0	0	0	0	0	0	272	896	0	1,552	0	0
Cyanophyceæ,	0	0	0	0	0	42	0	50	60	42	0	0
Anabæna,	0	0	0	0	0	42	0	6	40	40	0	0
Cœlosphærium,	0	0	0	0	0	0	0	36	20	2	0	0
Algæ,	0	0	0	4	1	32	11	108	8	214	142	161
Protococcus,	0	0	0	3	0	16	4	102	0	40	26	100
Raphidium,	0	0	0	1	0	4	0	4	0	96	34	13
Staurastrum,	0	0	0	0	1	2	1	2	4	72	4	0
Staurogenia,	0	0	0	0	0	0	0	0	0	4	38	48

MARLBOROUGH.

Microscopical Examination of Water from Millham Brook Storage Reservoir, Marlborough — Concluded.

[Number of organisms per cubic centimeter.]

	1897.											
	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
ANIMALS.												
Rhizopoda,	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**4**	**16**	**0**	**8**	**20**
Infusoria,	**44**	**2**	**14**	**91**	**350**	**7**	**1**	**36**	**180**	**154**	**260**	**48**
Dinobryon,	0	0	2	78	308	2	0	0	0	0	16	0
Euglena,	0	0	10	2	0	0	0	0	180	88	2	0
Mallomonas,	8	1	0	1	3	0	1	0	0	2	38	34
Synura,	28	0	0	0	36	0	0	0	0	2	0	0
Trachelomonas,	8	1	0	1	2	4	0	36	0	60	204	12
Vermes,	**0**	**0**	**0**	**2**	**0**	**1**	**0**	**0**	**8**	**0**	**0**	**2**
Crustacea,	**0**	**0**	**0**	**0**	**pr.**	**pr.**	**0**	**0**	**pr.**	**0**	**pr.**	**0**
Miscellaneous, Zoöglœa,	15	0	15	60	0	40	10	40	0	10	10	10
TOTAL,	651	195	33	240	9,823	2,150	295	1,418	1,656	2,512	802	1,981

Chemical Examination of Water from Millham Brook Storage Reservoir, Marlborough, collected near the Bottom.

[Parts per 100,000.]

Number.	Date of Collection.	Appearance.			Residue on Evaporation.		Ammonia.				Chlorine.	Nitrogen as		Oxygen Consumed.	Hardness.
		Turbidity.	Sediment.	Color.	Total.	Loss on Ignition.	Free.	Albuminoid.				Nitrates.	Nitrites.		
								Total.	Dissolved.	Sus-pended.					
	1897.														
18280	Jan. 18	V. slight.	V. slight.	1.20	6.75	2.55	.0106	.0322	.0312	.0010	.37	.0180	.0002	0.79	1.7
18446	Feb. 8	V. slight.	Slight.	1.20	6.05	2.50	.0210	.0386	.0354	.0032	.38	.0100	.0012	0.78	1.7
18716	Mar. 8	Slight.	Slight.	1.60	6.30	2.40	.0320	.0358	.0348	.0010	.36	.0070	.0011	0.88	1.9
18955	Apr. 5	Slight.	Slight.	0.63	4.00	1.35	.0040	.0226	.0198	.0028	.31	.0150	.0003	0.49	0.9
19209	May 10	Slight.	Slight.	0.80	4.15	1.60	.0062	.0266	.0208	.0058	.30	.0200	.0000	0.59	0.9
19409	June 8	V. slight.	Cons.	0.95	4.05	1.70	.0070	.0302	.0256	.0046	.22	.0030	.0000	0.65	1.3
19764	July 12	Slight.	V. slight.	1.95	5.50	2.35	.0538	.0370	.0262	.0108	.23	.0020	.0000	1.05	1.6
20024	Aug. 9	Distinct.	Cons., brown.	2.10	5.90	2.55	.0556	.0436	.0308	.0128	.24	.0020	.0000	1.03	1.7
20460	Sept 13	Slight.	Slight.	4.00	7.60	3.15	.0792	.0422	.0338	.0084	.26	.0020	.0000	1.16	2.2
20756	Oct. 11	V. slight.	V. slight.	1.23	4.70	2.50	.0016	.0358	.0308	.0050	.29	.0000	.0000	0.73	2.1
21080	Nov. 8	Slight.	Cons.	1.02	4.50	1.90	.0038	.0356	.0296	.0060	.46	.0020	.0001	0.70	1.8
21507	Dec. 13	Slight.	Cons.	0.95	4.50	2.35	.0046	.0312	.0262	.0050	.42	.0090	.0003	0.66	2.1
Av..	1897	....	....	1.47	5.33	2.24	.0233	.0343	.0288	.0055	.32	.0075	.0003	0.79	1.7
Av..	1896	....	....	1.04	5.07	1.94	.0185	.0331	.0271	.0060	.31	.0110	.0002	0.82	1.5

NOTE to analyses of 1897: Odor, generally distinctly vegetable and occasionally unpleasant. The iron was determined in all the samples, the average amount in parts per 100,000 being .1781. —— The samples were collected from the reservoir, 2 feet above the bottom.

Water Supply of Brant Rock, Marshfield. — Brant Rock Water Company.

Chemical Examination of Water from the Well of the Brant Rock Water Company.

[Parts per 100,000.]

Number.	Date of Collection.	Appearance.			Residue on Evaporation.	Ammonia.		Chlorine.	Nitrogen as		Oxygen Consumed.	Hardness.	Iron.
		Turbidity.	Sediment.	Color.		Free.	Albuminoid.		Nitrates.	Nitrites.			
	1897.												
19114	Apr. 26	None.	V. slight.	.00	11.00	.0002	.0026	3.07	.0800	.0000	.00	3.0	.0000
19770	July 12	None.	None.	.00	11.40	.0000	.0018	3.15	.0800	.0000	.00	2.2	.0020

Odor, none. —— The samples were collected from a faucet at the pumping station.

Mattapoisett.

The advice of the State Board of Health to Joseph K. Nye, with reference to a proposed water supply for the towns of Wareham, Marion, Mattapoisett and Fairhaven, may be found on pages 47 to 49 of this volume. The results of analyses of samples of water from the proposed sources of supply may be found under Wareham and Fairhaven in this volume.

Water Supply of Maynard.

Chemical Examination of Water from White Pond, Maynard.

[Parts per 100,000.]

Number.	Date of Collection.	Appearance.			Residue on Evaporation.		Ammonia.				Chlorine.	Nitrogen as		Oxygen Consumed.	Hardness.
		Turbidity.	Sediment.	Color.	Total.	Loss on Ignition.	Free.	Albuminoid. Total.	Albuminoid. Dissolved.	Albuminoid. Suspended.		Nitrates.	Nitrites.		
	1897.														
18864	Mar. 24	V. slight.	V. slight.	.06	2.40	1.00	.0006	.0124	.0106	.0018	.28	.0020	.0000	.16	0.6
19529	June 21	None.	None.	.02	2.35	1.05	.0000	.0186	.0170	.0016	.30	.0020	.0000	.13	0.2
20656	Sept. 28	V. slight.	V. slight.	.05	2.05	1.05	.0000	.0150	.0150	.0000	.40	.0000	.0000	.11	0.6
21678	Dec. 28	Slight.	Slight.	.10	3.00	1.00	.0010	.0100	.0100	.0000	.34	.0040	.0000	.20	1.3
Av...	....	....	....	.06	2.45	1.02	.0004	.0140	.0132	.0008	.33	.0020	.0000	.15	0.7

Odor, faintly vegetable. —— Nos. 18864 and 21678 were collected from a faucet in the town, and the others from the pond. The samples collected in the village represent pond water, mixed with a considerable amount of ground water which finds its way into the pipe leading from the pond to the pumping station.

Medfield.

Chemical Examination of Water from a Spring in Medfield.

[Parts per 100,000.]

Number.	Date of Collection	Appearance.[1]			Residue on Evaporation.	Ammonia.		Chlorine.	Nitrogen as		Oxygen Consumed.	Hardness.	Iron.
		Turbidity.	Sediment.	Color.		Free.	Albuminoid.		Nitrates.	Nitrites.			
19900	1897. July 24	None.	V. slight.	.06	3.40	.0000	.0028	.34	.0030	.0000	.12	1.6	.0000

Odor, none. —— The sample was collected from a spring near Vine Brook, about one-third of a mile above North Street. This spring is used as a source of water supply by a large straw factory and by a portion of the village of Medfield.

Water Supply of Medfield Insane Asylum.

The tubular wells near the Charles River, which were formerly used as a source of water supply for the Medfield Insane Asylum, were abandoned in 1897, and works for securing a supply of water from Farm Pond in Sherborn were constructed. Water is drawn from the pond by gravity to a pump well near the asylum, from which it is forced to a covered iron tank. Farm Pond has an area of 124 acres and a watershed of 200 acres, excluding the area of the pond. The watershed contains no permanent population, but the shores of the pond have been used to a considerable extent by picnic parties during the summer months.

The advice of the State Board of Health to the trustees of the Medfield Insane Asylum, in regard to the use of this pond as a source of water supply for the asylum, may be found on page 24 of the annual report for 1896, and the results of analyses of samples of water collected during the investigation made by the Board may be found on page 306 of the same volume.

Water Supply of Medford.

For information regarding the water supply of Medford from Spot Pond and for analyses of samples of water from the pond see pages 226 and 227.

MEDFORD.

Chemical Examination of Water from Wright's Pond, Medford.

[Parts per 100,000.]

Number.	Date of Collection.	Appearance.			Residue on Evaporation.		Ammonia.				Chlorine.	Nitrogen as		Oxygen Consumed.	Hardness.
		Turbidity.	Sediment.	Color.	Total.	Loss on Ignition.	Free.	Albuminoid. Total.	Albuminoid. Dissolved.	Albuminoid. Sus-pended.		Nitrates.	Nitrites.		
	1897.														
18384	Jau. 26	Slight.	Sllght.	.47	6.90	2.55	.0016	.0456	.0318	.0138	.65	.0070	.0002	.68	2.3
18651	Feb. 24	V. sllght.	V. slight.	.40	5.70	2.40	.0062	.0314	.0258	.0056	.55	.0070	.0001	.49	2.1
18873	Mar. 25	Sllght.	V. slight.	.35	4.80	1.95	.0096	.0152	.0140	.0012	.40	.0120	.0000	.27	1.6
19104	Apr. 26	Slight.	Slight.	.35	4.30	1.50	.0012	.0286	.0186	.0100	.43	.0000	.0000	.52	2.1
19323	May 25	Slight.	Cons.	.43	4.80	1.75	.0054	.0308	.0228	.0080	.41	.0030	.0000	.57	1.9
20331	Aug. 30	Slight.	V. slight.	.53	5.50	3.15	.0006	.0430	.0334	.0096	.39	.0000	.0000	.83	1.7
21597	Dec. 17	Decided.	Cons.	.50	6.05	2.05	.0118	.0252	.0188	.0064	.47	.0480	.0003	.54	2.3
Av...	....	....	....	.43	5.44	2.19	.0052	.0314	.0236	.0078	.47	.0110	.0001	.56	2.0

Odor of the first sample, distinctly fishy; of the second, faintly unpleasant, becoming faintly fishy on heating; of the others, vegetable.—— Nos. 18873, 19104 and 19323 were collected from a faucet at the pumping station; the other samples, from the pond.

Microscopical Examination of Water from Wright's Pond, Medford.

[Number of organisms per cubic centimeter.]

	1897. Jan.	Feb.	Mar.	Apr.	May.	Sept.	Dec.
Day of examination,	30	27	27	27	27	1	21
Number of sample,	18384	18651	18873	19104	19323	20331	21597
PLANTS.							
Diatomaceæ,	80	90	10	852	423	580	346
Asterionella,	28	10	0	436	5	12	100
Melosira,	0	0	0	148	180	0	106
Synedra,	52	80	2	236	232	536	128
Cyanophyceæ, Clathrocystis,	0	0	0	0	0	60	0
Algæ,	64	32	0	14	95	42	276
Raphidium,	60	0	0	8	40	4	48
Scenedesmus,	4	0	0	6	32	0	172
ANIMALS.							
Rhizopoda, Actinophrys,	0	0	0	0	0	0	2

MEDFORD.

Microscopical Examination of Water from Wright's Pond, Medford — Concluded.

[Number of organisms per cubic centimeter.]

	1897.						
	Jan.	Feb.	Mar.	Apr.	May.	Sept.	Dec.
ANIMALS — Con.							
Infusoria,	568	48	0	265	7	16	70
Dinobryon,	0	2	0	252	0	0	2
Euglena,	12	3	0	0	0	8	0
Peridinium,	524	40	0	0	0	2	44
Synura,	28	2	0	0	0	0	0
Trachelomonas,	4	0	0	8	5	4	24
Vermes,	2	1	0	0	0	4	0
Miscellaneous, Zoöglœa,	60	5	0	20	110	25	10
TOTAL,	774	176	10	1,151	635	727	704

Chemical Examination of Water from Underdrains beneath the Sewers, Medford.

[Parts per 100,000.]

Number.	Date of Collection.	Appearance.			Residue on Evaporation.	Ammonia.		Chlorine.	Nitrogen as		Oxygen Consumed.	Hardness.	Iron.
		Turbidity.	Sediment.	Color.		Free.	Albuminoid.		Nitrates.	Nitrites.			
	1897.												
18818	Mar. 18	None.	Slight.	.02	20.20	.0440	.0060	3.80	.6500	.0001	.06	5.9	.0130
19446	June 11	None.	Slight.	.00	25.90	.0768	.0056	3.90	.9500	.0014	.07	6.6	.0230
20811	Oct. 13	V. slight.	Slight.	.05	35.80	.0544	.0084	10.02	.4800	.0009	.11	9.7	.0120
Av...	....	....	....	.02	27.30	.0584	.0067	5.91	.6933	.0008	.08	7.4	.0160

Odor of the first sample, distinctly mouldy; of the second, distinctly unpleasant, disappearing on heating; of the last, none, becoming faintly musty on heating. —— The samples were collected from the underdrain in Boston Avenue, near the Mystic River.

MEDWAY.

The advice of the State Board of Health to the Medway Water Company, relative to a proposed water supply for that town to be taken from the ground near Charles River east of Medway Village, may be found on pages 28 to 31 of this volume. The results of analyses of samples of water collected from tubular test wells in the region in which it was proposed to locate the works, may be found on page 235 of the annual report for the year 1896.

Water Supply of Melrose.

For information regarding the water supply of Melrose from Spot Pond and for analyses of water from the pond, see pages 226 and 227.

Water Supply of Methuen.

Chemical Examination of Water from the Tubular Wells of the Methuen Water Works.

[Parts per 100,000.]

Number.	Date of Collection.	Appearance.			Residue on Evaporation.	Ammonia.		Chlorine.	Nitrogen as		Oxygen Consumed.	Hardness.	Iron.
		Turbidity.	Sediment.	Color.		Free.	Albu-minoid.		Nitrates.	Nitrites.			
	1897.												
18267	Jan. 18	None.	None.	.03	7.90	.0000	.0040	.25	.0030	.0002	.05	3.2	.0100
18806	Mar. 17	None.	None.	.05	6.00	.0006	.0034	.31	.0030	.0000	.06	2.7	.0120
19774	July 13	None.	None.	.11	7.30	.0000	.0030	.24	.0050	.0012	.17	3.1	.0020
20553	Sept. 16	None.	None.	.03	6.70	.0000	.0048	.26	.0030	.0000	.13	3.1	.0000
20554	Sept. 16	None.	V. slight.	.00	6.70	.0000	.0036	.25	.0030	.0000	.16	3.0	.0000
21301	Nov. 18	None.	None.	.11	7.30	.0006	.0046	.29	.0020	.0001	.07	4.3	.0020
Av.*	....	....	....	.06	7.04	.0002	.0038	.27	.0032	.0003	.10	3.3	.0052

* Where more than one sample was collected in a month, the mean analysis for that month has been used in making the average.

Odor, none. —— No. 19774 was collected from a faucet at the pumping station; the remaining samples, from faucets near the pumping station.

Chemical Examination of Water from the Covered Reservoir of the Methuen Water Works.

[Parts per 100,000.]

Number.	Date of Collection.	Appearance.			Residue on Evaporation.	Ammonia.		Chlorine.	Nitrogen as		Oxygen Consumed.	Hardness.	Iron.
		Turbidity.	Sediment.	Color.		Free.	Albu-minoid.		Nitrates.	Nitrites.			
	1897.												
18268	Jan. 18	None.	None.	.02	8.90	.0004	.0048	.28	.0030	.0000	.06	3.8	.0070
18807	Mar. 17	None.	None.	.03	6.10	.0006	.0046	.31	.0030	.0000	.05	2.7	.0100
19775	July 13	V. slight.	Slight.	.12	7.40	.0000	.0034	.25	.0050	.0003	.18	2.7	.0280
20555	Sept. 16	V. slight.	Slight.	.08	7.00	.0002	.0044	.28	.0030	.0000	.15	3.1	.0000
21300	Nov. 18	None.	None.	.07	7.00	.0004	.0042	.30	.0030	.0003	.06	4.3	.0020
Av.	....	....	....	.06	7.28	.0003	.0043	.28	.0034	.0001	.10	3.3	.0094

Odor, none. —— No. 21300 was collected from the reservoir; the remaining samples, from a faucet near the reservoir.

MIDDLEBOROUGH.

Water Supply of Middleborough Fire District, Middleborough.

Chemical Examination of Water from the Well of the Middleborough Fire District.

[Parts per 100,000.]

Number.	Date of Collection.	Appearance.			Residue on Evaporation.	Ammonia.		Chlorine.	Nitrogen as		Oxygen Consumed.	Hardness.	Iron.
		Turbidity.	Sediment.	Color.		Free.	Albuminoid.		Nitrates.	Nitrites.			
	1897.												
18432	Feb. 3	None.	None.	.03	7.00	.0000	.0022	.79	.1050	.0000	.05	2.5	.0090
18990	Apr. 12	None.	None.	.05	6.50	.0008	.0022	.75	.0700	.0001	.11	2.7	.0120
19391	June 7	None.	None.	.08	5.80	.0000	.0034	.66	.0550	.0000	.14	2.2	.0230
20276	Aug. 25	Distinct, milky.	V. slight.	.17	6.30	.0006	.0040	.67	.0350	.0000	.15	2.3	.0350
20731	Oct. 5	None.	Slight.	.07	5.80	.0006	.0062	.64	.0350	.0000	.10	2.2	.0450
21480	Dec. 8	V. slight.	Slight.	.12	6.30	.0018	.0054	.75	.0480	.0002	.12	3.0	.0120

Averages by Years.

-	1888	-	-	.00	8.67	.0001	.0025	.96	.1494	.0001	-	-	-
-	1895	-	-	.06	6.74	.0001	.0028	.74	.0687	.0000	.08	2.6	.0187
-	1896	-	-	.18	6.54	.0003	.0038	.72	.0565	.0000	.09	2.4	.0288
-	1897	-	-	.09	6.28	.0006	.0039	.71	.0580	.0000	.11	2.5	.0227

Note to analyses of 1897: Odor, none.—— The samples were collected from a faucet at the pumping station, while pumping.

Water Supply of Middleton.

(See *Danvers*.)

Water Supply of Milford and Hopedale. — Milford Water Company.

A statement in regard to a case of lead poisoning in Milford and in regard to the presence of lead in samples of water collected from faucets in the town may be found on pages 31 and 32 of this volume.

MILFORD.

Chemical Examination of Water from Faucets supplied from the Works of the Milford Water Company.

[Parts per 100,000.]

Number.	Date of Collection.	Appearance.			Residue on Evaporation.	Ammonia.		Chlorine.	Nitrogen as		Oxygen Consumed.	Hardness.	Iron.
		Turbidity.	Sediment.	Color.		Free.	Albuminoid.		Nitrates.	Nitrites.			
	1897.												
18424	Feb. 2	None.	None.	.15	3.10	.0008	.0070	.28	.0170	.0000	.21	1.3	.0050
18986	Apr. 8	None.	None.	.07	3.20	.0004	.0054	.28	.0180	.0000	.16	1.1	.0030
19386	June 5	None.	V. slight.	.12	2.80	.0000	.0042	.22	.0170	.0000	.20	0.9	.0120
20330	Aug. 30	V slight.	Slight.	.07	3.50	.0006	.0046	.30	.0180	.0000	.17	1.0	.0080
20758	Oct. 12	None.	None.	.00	3.60	.0008	.0072	.32	.0150	.0000	.10	1.3	.1400
Av...	....	....	....	.08	3.24	.0005	.0057	.28	.0170	.0000	.17	1.1	.0336

Odor of the first three samples, none; of the fourth, faintly unpleasant, disappearing on heating; of the last, faintly vegetable.—The samples were collected from a faucet.

Water Supply of Millbury. — Millbury Water Company.

Chemical Examination of Water from the Well of the Millbury Water Company.

[Parts per 100,000.]

Number.	Date of Collection.	Appearance.			Residue on Evaporation.	Ammonia.		Chlorine.	Nitrogen as		Oxygen Consumed.	Hardness.	Iron.
		Turbidity.	Sediment.	Color.		Free.	Albuminoid.		Nitrates.	Nitrites.			
	1897.												
18582	Feb. 20	None.	None.	.00	4.80	.0012	.0020	.22	.0150	.0000	.00	3.3	.0070
19066	Apr. 17	None.	None.	.02	6.50	.0100	.0030	.32	.0050	.0015	.09	4.7	.0030
19592	June 28	None.	None.	.00	4.40	.0010	.0016	.19	.0230	.0000	.05	1.9	.0030
20314	Aug. 28	None.	None.	.00	4.60	.0008	.0022	.20	.0150	.0000	.02	2.3	.0020
20819	Oct. 15	None.	None.	.00	4.70	.0006	.0006	.20	.0950	.0000	.01	2.2	.0010
21614	Dec. 20	None.	None.	.02	4.80	.0002	.0010	.24	.0160	.0000	.03	3.0	.0020
Av...	1897	....	....	.01	4.97	.0023	.0017	.23	.0282	.0002	.03	2.9	.0030
Av...	1896	....	....	.04	4.62	.0003	.0044	.25	.0160	.0001	.06	2.1	.0194

Note to analyses of 1897: Odor, none.—The samples were collected from a faucet at the pumping station.

MILLIS.

Water Supply of Millis.

Chemical Examination of Water from the Aqua Rex Spring, Millis.

[Parts per 100,000.]

Number.	Date of Collection.	Appearance.			Residue on Evaporation.	Ammonia.		Chlorine.	Nitrogen as		Oxygen Consumed.	Hardness.	Iron.
		Turbidity.	Sediment.	Color.		Free.	Albuminoid.		Nitrates.	Nitrites.			
	1897.												
19785	July 13	None.	None.	.00	6.30	.0006	.0008	.51	.1250	.0000	.00	2.3	.0000

Odor, none. —— The sample was collected from the spring.

Water Supply of Milton. — Milton Water Company.

The water supplied by this company to the town is purchased from the Hyde Park Water Company. Analyses of samples of the water may be found on pages 196 and 197.

Water Supply of Monson.

Chemical Examination of Water from a Faucet in Monson, supplied from the Monson Water Works.

[Parts per 100,000.]

Number.	Date of Collection.	Appearance.			Residue on Evaporation.	Ammonia.		Chlorine.	Nitrogen as		Oxygen Consumed	Hardness.	Iron.
		Turbidity.	Sediment.	Color.		Free.	Albuminoid.		Nitrates.	Nitrites.			
	1897.												
18374	Jan. 26	None.	None.	.00	4.60	.0002	.0034	.12	.0070	.0002	.00	1.3	.0000
18843	Mar. 22	None.	None.	.00	2.90	.0000	.0018	.11	.0070	.0000	.01	0.9	.0030
19340	May 31	None.	None.	.00	9.20	.0002	.0008	.13	.0070	.0000	.05	0.8	.0150
20004	Aug. 4	None.	None.	.00	3.20	.0002	.0008	.10	.0100	.0000	.04	1.1	.0000
20640	Sept. 27	None.	None.	.00	9.00	.0002	.0008	.11	.0040	.0000	.02	1.4	.0550
21481	Dec. 7	V. slight.	V. slight.	.02	3.60	.0008	.0036	.14	.0090	.0001	.03	1.7	.0010
Av...	1897	....	....	.00	5.42	.0003	.0019	.12	.0073	.0000	.02	1.2	.0123
Av...	1896	....	....	.00	3.95	.0004	.0015	.13	.0103	.0000	.03	1.7	.0092

Note to analyses of 1897: Odor, none. —— The samples were collected from a faucet in the town.

MONSON.

Massachusetts Hospital for Epileptics, Monson.

The advice of the State Board of Health to the trustees of the Massachusetts Hospital for Epileptics, relative to a proposed water supply for the hospital to be taken from the ground in the vicinity of the Quaboag River, may be found on pages 26 and 27 of this volume. The results of analyses of samples of water collected during the investigations made by the Board may be found on page 241 of the annual report for 1896.

Water Supply of Turner's Falls Fire District, Montague.

Chemical Examination of Water from Lake Pleasant, Montague.

[Parts per 100,000.]

Number.	Date of Collection.	Appearance.			Residue on Evaporation.		Ammonia.				Chlorine.	Nitrogen as		Oxygen Consumed.	Hardness.
		Turbidity.	Sediment.	Color.	Total.	Loss on Ignition.	Free.	Albuminoid. Total.	Albuminoid. Dissolved.	Albuminoid. Suspended.		Nitrates.	Nitrites.		
	1897.														
18382	Jan. 26	Slight.	V. slight.	.06	2.25	0.55	.0040	.0112	.0100	.0012	.15	.0000	.0000	.13	0.6
18706	Mar. 3	V. slight.	V. slight.	.05	2.15	0.70	.0052	.0084	.0084	.0000	.11	.0000	.0000	.17	0.5
19215	May 11	V. slight.	V. slight.	.02	1.85	0.40	.0006	.0064	.0060	.0004	.15	.0030	.0000	.06	0.3
19740	July 7	V. slight.	V. slight.	.01	1.90	0.65	.0008	.0082	.0066	.0016	.13	.0020	.0003	.15	0.2
20416	Sept. 8	V. slight.	V. slight.	.04	2.45	0.90	.0002	.0076	.0064	.0012	.14	.0000	.0000	.16	0.5
21117	Nov. 10	V. slight.	V. slight.	.13	2.55	0.80	.0032	.0104	.0098	.0006	.15	.0000	.0000	.10	0.8
Av...	....	....	....	.05	2.19	0.67	.0023	.0087	.0079	.0008	.14	.0008	.0000	.13	0.5

Odor, faintly vegetable. In May the odor became fishy and oily on heating.—— The first sample was collected from the lake; the second, from a faucet at the pumping station; the remaining samples, from a faucet in the village.

Microscopical Examination.

The organism *Uroglena* was found in small numbers in the sample examined in January and the organism *Dinobryon* was found in the samples examined in January, March and November.

Water Supply of Nahant.

(See *Swampscott.*)

NANTUCKET.

WATER SUPPLY OF NANTUCKET. — WANNACOMET WATER COMPANY.

Chemical Examination of Water from Wannacomet Pond, Nantucket.

[Parts per 100,000.]

Number.	Date of Collection.	Appearance.			Residue on Evaporation.		Ammonia.				Chlorine.	Nitrogen as		Oxygen Consumed.	Hardness.
		Turbidity.	Sediment.	Color.	Total.	Loss on Ignition.	Free.	Albuminoid. Total.	Albuminoid. Dissolved.	Albuminoid. Suspended.		Nitrates.	Nitrites.		
	1897.														
18303	Jan. 18	V. slight.	V. slight.	.03	6.60	1.40	.0008	.0132	.0120	.0012	2.41	.0000	.0000	.09	1.6
18422	Feb. 1	V. slight.	V. slight.	.02	6.45	1.40	.0008	.0218	.0128	.0090	2.60	.0020	.0000	.10	1.6
18693	Mar. 1	V. slight.	V. slight.	.03	6.60	1.30	.0008	.0118	.0100	.0018	2.47	.0030	.0000	.15	1.3
18975	April 6	V. slight.	Slight.	.02	5.95	1.55	.0004	.0138	.0118	.0020	2.42	.0000	.0000	.12	1.6
19171	May 4	V. slight.	V. slight.	.02	6.30	1.50	.0024	.0152	.0122	.0030	2.39	.0030	.0000	.14	1.8
19383	June 2	V. slight.	V. slight.	.03	6.40	1.35	.0012	.0136	.0112	.0024	2.37	.0030	.0000	.10	1.4
19731	July 6	V. slight.	V. slight.	.02	6.50	1.65	.0018	.0134	.0124	.0010	2.42	.0020	.0000	.12	1.4
19996	Aug. 3	Slight.	V. slight.	.06	6.55	1.65	.0024	.0176	.0132	.0044	2.32	.0000	.0000	.15	1.6
20389	Sept. 6	Distinct.	Cons.	.12	7.10	2.00	.0000	.0366	.0156	.0210	2.28	.0020	.0000	.25	1.6
20625	Sept. 22	Slight.	Slight.	.30	7.40	1.95	.0006	.0368	.0262	.0106	2.70	.0000	.0000	.15	1.6
20730	Oct. 5	Slight.	V. slight.	.20	7.10	1.55	.0006	.0288	.0182	.0106	2.42	.0020	.0000	.14	1.8
21045	Nov. 3	V. slight.	Decided.	.14	7.35	2.00	.0036	.0212	.0174	.0038	2.41	.0000	.0000	.14	1.7
21467	Dec. 6	Decided.	Cons.	.20	6.90	1.60	.0012	.0154	.0120	.0034	2.34	.0030	.0001	.11	1.7
Av.*	....	....	....	.08	6.66	1.58	.0014	.0186	.0137	.0049	2.42	.0016	.0000	.13	1.6

* Where more than one sample was collected in a month, the mean analysis for that month has been used in making the average.

Odor, vegetable; of the last sample, also fishy.—— No. 21467 was collected from a faucet at the pumping station; the remaining samples, from the pond.

Microscopical Examination of Water from Wannacomet Pond, Nantucket.

[Number of organisms per cubic centimeter]

	1897.												
	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Oct.	Nov.	Dec.
Day of examination, . . .	21	5	5	8	7	5	8	5	8	2	8	5	8
Number of sample, . . .	18303	18422	18693	18975	19171	19383	19731	19996	20389	20625	20730	21045	21467
PLANTS.													
Diatomaceæ, ...	0	6	0	157	5	28	2	4	0	2	0	23	134
Asterionella, ...	0	0	0	0	0	0	0	0	0	0	0	19	100
Synedra, ...	0	6	0	156	1	20	0	4	0	2	0	1	8
Cyanophyceæ, Anabæna,	0	0	0	0	0	0	0	124	1,520	0	716	44	0
Algæ, ...	0	0	0	0	0	2	0	0	0	5	0	6	39

NANTUCKET.

Microscopical Examination of Water from Wannacomet Pond, Nantucket — Concluded.

[Number of organisms per cubic centimeter.]

	1897.												
	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Oct.	Nov.	Dec.
ANIMALS.													
Infusoria,	**60**	**52**	**14**	**529**	**196**	**20**	**43**	**1**	**5**	**0**	**2**	**438**	**1,606**
Dinobryon,	60	48	13	524	182	16	42	0	0	0	0	432	1,600
Peridinium,	0	4	0	2	11	0	0	0	0	0	0	1	4
Vermes,	**0**	**0**	**0**	**2**	**1**	**0**	**2**	**0**	**4**	**1**	**0**	**6**	**0**
Crustacea,	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**pr.**	**0**	**pr.**	**pr.**	**pr**
Miscellaneous, Zoöglœa,	**0**	**0**	**0**	**0**	**10**	**40**	**0**	**5**	**3**	**40**	**15**	**0**	**5**
TOTAL,	60	58	14	688	212	90	47	134	1,532	48	733	517	1,784

Chemical Examination of Water from Wannacomet Pond after Filtration.

[Parts per 100,000.]

Number.	Date of Collection.	Appearance.			Residue on Evaporation.	Ammonia.		Chlorine.	Nitrogen as		Oxygen Consumed.	Hardness.	Iron.
		Turbidity.	Sediment.	Color.		Free.	Albuminoid.		Nitrates.	Nitrites.			
20626	1897. Sept. 22	V. slight.	V. slight.	.28	7.10	.0020	.0180	2.85	.0020	.0000	.12	1.3	.0550

Odor, distinctly vegetable, becoming also grassy on heating. —— The sample was collected from a faucet at the pumping station, while drawing water from the filter.

Microscopical Examination.

Diatomaceæ, *Eunotia*, 2; *Gomphonema*, 1; *Meridion*, 2; *Navicula*, 2; *Synedra*, 5; *Tabellaria*, 4; *Triceratium*, 1. Cyanophyceæ, *Cœlosphærium*, 2. Algæ, *Arthrodesmus*, 1; *Protococcus*, 17; *Scenedesmus*, 1; *Staurastrum*, 1; *Staurogenia*, 12. Infusoria, *Ceratium*, 1; *Dinobryon*, 7; *Euglena*, 100; *Peridinium*, 2; *Trachelomonas*, 1. Vermes, *Anurea*, 1. Miscellaneous, *Zoöglœa*, 100. Total, 263.

Water Supply of Natick.

The advice of the State Board of Health to the town of Natick, relative to a proposed additional water supply for the town to be taken from the ground near Lake Cochituate, may be found on

NATICK.

pages 32 and 33 of this volume. The results of analyses of samples of water collected from test wells at the place where it is proposed to locate the works are given in the following tables: —

Chemical Examination of Water from Dug Pond, Natick.

[Parts per 100,000.]

Number.	Date of Collection.	Appearance. Turbidity.	Appearance. Sediment.	Appearance. Color.	Residue on Evaporation. Total.	Residue on Evaporation. Loss on Ignition.	Ammonia. Free.	Ammonia. Albuminoid. Total.	Ammonia. Albuminoid. Dissolved.	Ammonia. Albuminoid. Suspended.	Chlorine.	Nitrogen as Nitrates.	Nitrogen as Nitrites.	Oxygen Consumed.	Hardness.
	1897.														
18240	Jan. 12	V. slight.	V. slight.	.08	6.40	1.25	.0184	.0188	.0182	.0006	.88	.0180	.0002	.24	2.2
18404	Feb. 1	Slight.	V. slight.	.30	5.80	1.60	.0062	.0158	.0150	.0008	.88	.0270	.0002	.22	2.5
18670	Mar. 1	V. slight.	V. slight.	.07	5.70	1.45	.0142	.0182	.0154	.0028	.85	.0250	.0010	.27	3.0
18943	April 2	Slight.	V. slight.	.07	5.50	1.85	.0070	.0164	.0140	.0024	.86	.0280	.0002	.26	2.3
19146	May 3	V. slight.	V. slight.	.12	5.75	1.80	.0026	.0246	.0198	.0048	.85	.0250	.0002	.28	2.5
19347	June 1	V. slight.	V. slight.	.12	4.05	1.00	.0010	.0158	.0134	.0024	.81	.0130	.0000	.17	2.5
19703	July 1	V. slight.	V. slight.	.11	5.30	1.45	.0014	.0220	.0194	.0026	.88	.0030	.0001	.26	2.1
19956	Aug. 2	V. slight.	V. slight.	.07	5.35	1.70	.0016	.0220	.0166	.0054	.82	.0030	.0000	.26	2.3
20333	Sept. 1	V. slight.	V. slight.	.08	5.25	1.45	.0008	.0170	.0134	.0036	.76	.0030	.0000	.22	2.2
20708	Oct. 4	V. slight.	V. slight.	.12	5.25	1.75	.0000	.0172	.0150	.0022	.82	.0030	.0000	.22	2.3
21027	Nov. 1	V. slight.	V. slight.	.16	5.30	1.30	.0118	.0224	.0202	.0022	.82	.0000	.0001	.39	2.1
21400	Dec. 1	V. slight.	Slight.	.20	5.30	1.10	.0108	.0206	.0190	.0016	.84	.0080	.0000	.20	2.7

Averages by Years.

-	1888	-	-	.13	5.24	1.09	.0070	.0228	-	-	.66	.0197	.0003	-	-
-	1889	-	-	.16	5.55	1.20	.0046	.0242	.0197	.0045	.71	.0292	.0004	-	-
-	1890	-	-	.14	5.85	1.36	.0027	.0199	.0166	.0033	.72	.0227	.0002	-	2.7
-	1891	-	-	.09	5.71	1.45	.0085	.0207	.0167	.0040	.69	.0326	.0003	-	2.4
-	1892	-	-	.06	5.38	1.24	.0068	.0173	.0135	.0038	.72	.0323	.0001	-	2.4
-	1893	-	-	.08	5.28	1.39	.0062	.0192	.0158	.0034	.71	.0193	.0003	.23	2.1
-	1894	-	-	.10	5.64	1.65	.0060	.0155	.0132	.0023	.80	.0218	.0001	.21	2.3
-	1895	-	-	.13	6.27	1.86	.0044	.0191	.0164	.0027	.87	.0312	.0001	.24	2.6
-	1896	-	-	.15	6.19	1.77	.0045	.0176	.0147	.0029	.86	.0290	.0002	.25	2.3
-	1897	-	-	.12	5.41	1.47	.0063	.0192	.0166	.0026	.84	.0130	.0002	.25	2.4

NOTE to analyses of 1897: Odor, distinctly vegetable, occasionally mouldy and unpleasant.—— The samples were collected from the pond. For monthly record of height of water in this pond, see page 247.

NATICK.

Microscopical Examination of Water from Dug Pond, Natick.

[Number of organisms per cubic centimeter.]

	1897.											
	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
Day of examination,	13	3	2	3	4	2	3	3	2	5	3	2
Number of sample,	18240	18404	18670	18943	19146	19347	19703	19956	20333	20708	21027	21400
PLANTS.												
Diatomaceæ,	825	10	142	450	427	97	11	90	41	90	268	1,624
Asterionella,	628	0	2	8	14	8	0	0	1	6	18	1,000
Melosira,	2	0	0	120	0	5	7	18	0	10	156	194
Tabellaria,	188	6	116	300	388	84	0	52	39	38	88	376
Cyanophyceæ,	0	0	0	0	0	0	62	268	2	2	2	0
Cœlosphærium,	0	0	0	0	0	0	0	40	0	0	2	0
Microcystis,	0	0	0	0	0	0	56	228	2	2	0	0
Algæ,	1	0	0	0	0	1	10	0	0	26	30	4
ANIMALS.												
Rhizopoda, Actinophrys,	0	0	0	0	0	0	0	0	0	0	2	0
Infusoria,	0	4	11	31	750	1	432	2	2	46	214	10
Dinobryon,	0	0	0	28	740	1	432	0	2	36	208	8
Vermes,	1	0	0	1	0	0	0	0	0	2	2	0
Crustacea, Cyclops,	0	0	pr.	0	0	0	0	0	0	0	0	0
Miscellaneous, Zoöglœa,	5	90	20	5	5	5	20	10	5	10	0	15
TOTAL,	832	104	173	487	1,182	104	535	370	50	176	518	1,653

Table showing Heights of Water in Dug Pond on the First of Each Month in 1897.

[High-water mark is 13.0 feet]

1897.	Height of Water.	1897.	Height of Water.
	Feet.		Feet.
Jan. 1,	8.92	July 1,	11.17
Feb. 1,	9.58	Aug. 1,	10.25
March 1,	10.25	Sept. 1,	9.58
April 1,	12.25	Oct. 1,	8.83
May 1,	12.42	Nov. 1,	7.92
June 1,	11.92	Dec. 1,	8.42

NATICK.

Chemical Examination of Water from Tubular Test Wells in Natick.

[Parts per 100,000.]

Number.	Date of Collection.	Appearance.			Residue on Evaporation.	Ammonia.		Chlorine.	Nitrogen as		Oxygen Consumed.	Hardness.	Iron.
		Turbidity.	Sediment.	Color.		Free.	Albuminoid.		Nitrates.	Nitrites.			
	1897.												
20461	Sept. 13	Distinct, clayey.	Cons. sandy.	.02	5.10	.0002	.0016	.22	.0000	.0000	.04	1.9	.0000
20462	Sept. 13	V. slight	Slight.	.00	4.00	.0002	.0002	.20	.0000	.0000	.00	1.4	.0010

Odor, none.——The first sample was collected from well No. 2; the second, from well No. 1. These test wells are located near Lake Cochituate, in the area bounded by the Worcester turnpike, the Saxonville branch of the Boston & Albany Railroad and the southern division of the lake.

Water Supply of Needham.

The advice of the State Board of Health to the town of Needham, with reference to the protection of the purity of the water supply of the town, may be found on pages 92 and 93 of this volume.

Chemical Examination of Water from the Needham Water Works.

[Parts per 100,000.]

Number.	Date of Collection.	Appearance.			Residue on Evaporation.	Ammonia.		Chlorine.	Nitrogen as		Oxygen Consumed.	Hardness.	Iron.
		Turbidity.	Sediment.	Color.		Free.	Albuminoid.		Nitrates.	Nitrites.			
	1897.												
19715	July 5	None.	None.	.00	5.90	.0000	.0020	.82	.1600	.0000	.06	1.8	.0000

Averages by Years.

-	1893	-	-	.00	5.28	.0000	.0007	.63	.1230	.0000	.05	1.9	.0000
-	1894	-	-	.01	5.18	.0013	.0005	.66	.1367	.0000	.01	1.7	.0020
-	1896	-	-	.00	6.65	.0000	.0009	.90	.1575	.0000	.02	2.0	.0010
-	1897	-	-	.00	5.90	.0000	.0020	.82	.1600	.0000	.06	1.8	.0000

Note to analysis of 1897: Odor, none.——The sample was collected from a faucet at a drinking fountain.

Water Supply of New Bedford.

The advice of the State Board of Health to the city of New Bedford, with reference to the protection of the purity of the water supply of the city, may be found on pages 91 and 92 of this volume.

NEW BEDFORD.

Chemical Examination of Water from the Conduit of the New Bedford Water Works.

[Parts per 100,000.]

Number.	Date of Collection.	Appearance.			Residue on Evaporation.		Ammonia.				Chlorine.	Nitrogen as		Oxygen Consumed.	Hardness.
		Turbidity.	Sediment.	Color.	Total.	Loss on Ignition.	Free.	Albuminoid. Total.	Albuminoid. Dissolved.	Albuminoid. Suspended.		Nitrates.	Nitrites.		
	1897.														
18337	Jan. 25	V. slight.	V. slight.	1.50	6.40	3.40	.0030	.0262	.0262	.0000	.67	.0070	.0001	1.24	1.3
18611	Feb. 23	V. slight.	V. slight.	1.20	5.55	2.50	.0024	.0184	.0176	.0008	.70	.0030	.0000	1.05	1.0
18853	Mar. 23	V. slight.	Slight.	0.85	3.75	1.50	.0020	.0158	.0152	.0006	.58	.0050	.0002	0.70	0.6
19135	Apr. 28	V. slight.	Cons.	1.25	4.30	1.95	.0010	.0190	.0170	.0020	.50	.0030	.0000	1.06	1.1
19330	May 26	V. slight.	Slight.	1.60	4.65	2.60	.0010	.0260	.0254	.0006	.50	.0060	.0000	1.28	0.6
19533	June 21	V. slight.	V. slight.	1.73	5.10	2.60	.0008	.0236	.0192	.0044	.47	.0060	.0000	1.26	0.8
19911	July 26	V. slight.	Slight.	1.65	5.35	2.50	.0004	.0254	.0236	.0018	.55	.0100	.0000	1.66	1.1
20245	Aug. 23	V. slight.	V. slight.	1.25	4.75	2.35	.0018	.0284	.0250	.0034	.53	.0000	.0000	1.08	1.1
20653	Sept. 27	V. slight.	Slight.	1.82	5.50	3.15	.0006	.0252	.0236	.0016	.56	.0020	.0000	1.29	1.3
20951	Oct. 25	V. slight.	V. slight.	1.15	4.50	2.25	.0022	.0264	.0256	.0008	.68	.0070	.0000	0.77	1.4
21315	Nov. 22	V. slight.	V. slight.	1.18	5.40	2.45	.0050	.0288	.0282	.0006	.64	.0070	.0003	1.02	1.3
21723	Dec. 31	V. slight.	Slight.	1.70	6.80	3.40	.0054	.0296	.0254	.0042	.70	.0070	.0001	1.38	1.6
Av..	....	....	....	1.41	5.17	2.55	.0021	.0244	.0227	.0017	.59	.0052	.0001	1.15	1.1

Odor, distinctly vegetable. —— The samples were collected from the conduit, at its entrance to the receiving reservoir, and represent water from the storage reservoir. For monthly record of height of water, see page 252.

Microscopical Examination of Water from the Conduit of the New Bedford Water Works.

[Number of organisms per cubic centimeter.]

	1897.											1898.
	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Oct.	Oct.	Nov.	Jan.
Day of examination, . . .	27	25	26	29	28	22	28	24	4	26	23	3
Number of sample, . . .	18337	18611	18853	19135	19330	19533	19911	20245	20653	20951	21315	21723
PLANTS.												
Diatomaceæ, ...	0	2	15	4	1	0	1	0	1	0	102	2
Asterionella, ...	0	0	14	0	0	0	0	0	0	0	96	0
Cyanophyceæ, Merismopœdia,	0	0	0	0	0	0	27	2	0	0	0	0
Algæ, Protococcus, . . .	1	2	0	0	0	0	2	17	0	0	0	0

NEW BEDFORD.

Microscopical Examination of Water from the Conduit of the New Bedford Water Works — Concluded.

[Number of organisms per cubic centimeter.]

	1897.											1898.
	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Oct.	Oct.	Nov.	Jan.
ANIMALS.												
Rhizopoda, Difflugia,	0	0	0	0	0	1	0	0	0	0	0	0
Infusoria,	14	2	18	0	1	0	0	1	2	0	1	0
Dinobryon,	12	0	14	0	0	0	0	0	0	0	0	0
Miscellaneous, Zoöglœa,	15	20	0	0	0	25	45	10	10	3	5	5
TOTAL,	30	26	33	4	2	26	75	30	13	3	108	7

Chemical Examination of Water from Little Quittacas Pond, Lakeville

[Parts per 100,000.]

Number.	Date of Collection.	Appearance.			Residue on Evaporation.		Ammonia.				Chlorine.	Nitrogen as		Oxygen Consumed.	Hardness.
		Turbidity.	Sediment.	Color.	Total.	Loss on Ignition.	Free.	Albuminoid. Total.	Albuminoid. Dissolved.	Albuminoid. Sus-pended.		Nitrates.	Nitrites.		
	1897.														
18850	Mar. 23	Slight.	Slight.	.20	2.90	0.85	.0006	.0254	.0150	.0104	.54	.0050	.0000	.30	0.6
19534	June 21	V. slight.	V. slight.	.22	2.80	0.95	.0020	.0172	.0142	.0030	.53	.0020	.0000	.34	0.6
20651	Sept. 27	V. slight.	V. slight.	.15	3.05	1.20	.0002	.0162	.0152	.0010	.56	.0000	.0000	.32	0.6
21712	Dec. 29	Slight.	Slight.	.16	3.40	1.30	.0002	.0166	.0140	.0026	.61	.0010	.0000	.26	1.1
Av...	....	....	....	.18	3.04	1.07	.0007	.0188	.0146	.0042	.56	.0020	.0000	.30	0.7

Odor of the first three samples, distinctly vegetable; of the last, none, becoming faintly vegetable on heating. —— The samples were collected from the pond. For monthly record of height of water in this pond, see page 252.

NEW BEDFORD.

Chemical Examination of Water from Great Quittacas Pond, Lakeville.

[Parts per 100,000.]

Number.	Date of Collection.	Appearance.			Residue on Evaporation.		Ammonia.				Chlorine.	Nitrogen as		Oxygen Consumed.	Hardness.
		Turbidity.	Sediment.	Color.	Total.	Loss on Ignition.	Free.	Albuminoid. Total.	Albuminoid. Dissolved.	Albuminoid. Suspended.		Nitrates.	Nitrites.		
	1897.														
18851	Mar. 23	V. slight.	V. slight.	.67	3.40	1.25	.0008	.0180	.0170	.0010	.57	.0000	.0002	.62	0.8
19535	June 21	None.	V. slight.	.60	3.35	1.40	.0010	.0160	.0138	.0022	.52	.0000	.0000	.60	0.6
20650	Sept. 27	V. slight.	V. slight.	.43	3.60	1.85	.0000	.0136	.0122	.0014	.58	.0000	.0000	.57	0.5
21711	Dec. 29	V. slight.	V. slight.	.46	3.90	1.40	.0002	.0166	.0164	.0002	.64	.0010	.0000	.53	1.0
Av...	....	....	....	.54	3.56	1.47	.0005	.0160	.0148	.0012	.58	.0002	.0000	.58	0.7

Odor, vegetable.—— The samples were collected from the pond.

Chemical Examination of Water from Long Pond, Lakeville.

[Parts per 100,000.]

Number.	Date of Collection.	Appearance.			Residue on Evaporation.		Ammonia.				Chlorine.	Nitrogen as		Oxygen Consumed.	Hardness.
		Turbidity.	Sediment.	Color.	Total.	Loss on Ignition.	Free.	Albuminoid. Total.	Albuminoid. Dissolved.	Albuminoid. Suspended.		Nitrates.	Nitrites.		
	1897.														
18852	Mar. 23	V. slight.	V. slight.	1.10	3.95	1.90	.0004	.0190	.0182	.0008	.56	.0030	.0002	.88	0.8
19532	June 21	V. slight.	V. slight.	1.10	3.95	1.85	.0010	.0166	.0150	.0016	.49	.0000	.0000	.92	0.5
20652	Sept. 27	Slight.	Slight.	0.63	3.60	2.00	.0002	.0238	.0224	.0014	.56	.0000	.0000	.74	0.3
21713	Dec. 29	V. slight.	V. slight.	1.02	4.50	2.25	.0002	.0220	.0208	.0012	.64	.0010	.0000	.95	1.0
Av...	....	....	....	0.96	4.00	2.00	.0004	.0203	.0191	.0012	.56	.0010	.0000	.87	0.6

Odor, distinctly vegetable.—— The samples were collected from the pond.

NEW BEDFORD.

Table showing Heights of Water in Acushnet Reservoir and Little Quittacas Pond on the First of Each Month in 1897.

1897.	Acushnet Reservoir. Distance below High-water Mark.	Little Quittacas Pond. Distance below High-water Mark.	1897.	Acushnet Reservoir. Distance below High-water Mark.	Little Quittacas Pond. Distance below High-water Mark.
	Feet.	Feet.		Feet.	Feet.
Jan. 1, ...	0.33	0.58	July 1, ...	0.25	0.42
Feb. 1, ...	0.08	0.21	Aug. 1, ...	0.17	1.08
Mar. 1, ...	0.00	0.08	Sept. 1, ...	0.00	1.58
April 1, ...	0.17	0.33	Oct. 1, ...	0.33	3.08
May 1, ...	0.00	0.33	Nov. 1, ...	1.75	2.92
June 1, ...	0.00	0.33	Dec. 1, ...	0.58	2.00

Water Supply of Newburyport.

Chemical Examination of Water from the Newburyport Water Works.

[Parts per 100,000.]

Number.	Date of Collection.	Appearance.			Residue on Evaporation.	Ammonia.		Chlorine.	Nitrogen as		Oxygen Consumed.	Hardness.	Iron.
		Turbidity.	Sediment.	Color.		Free.	Albuminoid.		Nitrates.	Nitrites.			
	1897.												
18262	Jan. 18	Distinct, clayey.	V. slight.	.23	7.90	.0004	.0028	.55	.0180	.0002	.00	2.6	.0530
18508	Feb. 15	Distinct, milky.	V. slight.	.10	5.70	.0006	.0020	.47	.0300	.0000	.01	2.2	.0370
18774	Mar. 15	Distinct, milky.	V. slight.	.10	6.00	.0002	.0016	.48	.0280	.0000	.01	2.2	.0350
19068	Apr. 20	V. slight, milky.	V. slight.	.07	6.00	.0004	.0026	.45	.0280	.0000	.06	2.5	.0300
19259	May 17	Distinct, milky.	Slight.	.28	6.90	.0010	.0112	.44	.0150	.0001	.16	2.6	.0150
19460	June 14	V. slight.	Slight.	.02	6.80	.0004	.0028	.42	.0300	.0000	.10	2.7	.0120
19821	July 19	V. slight.	V. slight.	.10	6.00	.0004	.0022	.49	.0120	.0000	.06	2.3	.0120
20106	Aug. 16	None.	V. slight.	.15	6.70	.0012	.0024	.47	.0220	.0000	.06	2.7	.0240
20567	Sept. 20	V. slight, milky.	None.	.07	6.70	.0008	.0060	.45	.0150	.0000	.10	2.6	.0060
20827	Oct. 18	V. slight, milky.	V. slight.	.12	6.80	.0008	.0046	.47	.0380	.0000	.06	2.7	.0060
21240	Nov. 15	Slight.	None.	.16	6.60	.0012	.0034	.53	.0450	.0001	.06	3.4	.0230
21598	Dec. 20	Distinct.	Slight.	.22	8.10	.0012	.0084	.52	.0280	.0001	.14	3.6	.0180
Av...	....	....	....	.13	6.68	.0007	.0042	.48	.0257	.0000	.07	2.7	.0226

Odor, none. —— The first four samples were collected from a faucet in the town; the remaining samples, from a faucet at the pumping station.

Water Supply of Newton.

Chemical Examination of Water from a Faucet at the Newton Water Works Pumping Station.

[Parts per 100,000.]

Number.	Date of Collection.	Appearance.			Residue on Evaporation.	Ammonia.		Chlorine.	Nitrogen as		Oxygen Consumed.	Hardness.	Iron.
		Turbidity.	Sediment.	Color.		Free.	Albu-minoid.		Nitrates.	Nitrites.			
	1897.												
18494	Feb. 15	None.	V. slight.	.05	6.10	.0004	.0022	.50	.0330	.0000	.02	3.0	.0500
19081	Apr. 20	None.	Slight.	.02	4.70	.0010	.0024	.42	.0300	.0000	.08	2.3	.0080
19537	June 22	None.	None.	.00	5.00	.0000	.0014	.42	.0320	.0000	.04	2.3	.0000
20111	Aug. 16	None.	V. slight.	.03	6.00	.0006	.0024	.42	.0150	.0000	.07	3.0	.0060
20821	Oct. 18	None.	None.	.03	6.20	.0008	.0050	.45	.0550	.0000	.09	2.7	.0010
21612	Dec. 20	V. slight.	Slight.	.13	6.80	.0002	.0026	.56	.0450	.0000	.11	3.3	.0080

Averages by Years.

-	1888	-	-	.01	4.64	.0009	.0111	.35	.0072	.0001	-	-	-
-	1889	-	-	.01	4.01	.0002	.0061	.30	.0119	.0001	-	-	-
-	1892	-	-	.02	5.13	.0006	.0028	.35	.0190	.0001	-	2.4	.0179
-	1893	-	-	.03	5.08	.0004	.0019	.38	.0194	.0000	.09	2.3	.0119
-	1894	-	-	.03	5.99	.0001	.0021	.40	.0157	.0000	.05	2.7	.0110
-	1895	-	-	.03	5.85	.0001	.0023	.42	.0230	.0000	.06	2.4	.0146
-	1896	-	-	.02	5.70	.0007	.0024	.41	.0260	.0000	.06	2.6	.0108
-	1897	-	-	.04	5.80	.0005	.0027	.46	.0350	.0000	.07	2.8	.0122

Note to analyses of 1897: Odor, none.—The samples were collected from a faucet at the pumping station.

Chemical Examination of Water from the Covered Distributing Reservoir of the Newton Water Works.

[Parts per 100,000.]

Number.	Date of Collection.	Appearance.			Residue on Evaporation.	Ammonia.		Chlorine.	Nitrogen as		Oxygen Consumed.	Hardness.	Iron.
		Turbidity.	Sediment.	Color.		Free.	Albu-minoid.		Nitrates.	Nitrites.			
	1897.												
18495	Feb. 15	None.	Cons., iron.	.03	5.80	.0004	.0084	.49	.0300	.0000	.03	3.0	.1000
19082	Apr. 20	None.	Slight.	.02	5.30	.0010	.0030	.45	.0300	.0000	.07	2.7	.0050
19538	June 22	V. slight.	V. slight.	.00	6.00	.0000	.0016	.40	.0350	.0000	.05	2.9	.0100
20112	Aug. 16	V. slight.	Cons.	.06	7.50	.0006	.0064	.44	.0180	.0000	.13	3.2	.2200
20822	Oct. 18	V. slight, milky.	Cons.	.03	7.80	.0004	.0036	.45	.0450	.0000	.15	3.8	.0470
21613	Dec. 20	Decided.	Cons.	.09	8.40	.0028	.0036	.52	.0180	.0000	.06	3.6	.0230

Averages by Years.

-	1892	-	-	.03	6.40	.0022	.0038	.35	.0246	.0003	-	3.0	.0242
-	1893	-	-	.04	6.40	.0000	.0027	.38	.0220	.0000	.07	3.0	.0196
-	1894	-	-	.03	6.44	.0002	.0038	.40	.0149	.0000	.07	2.9	.0352
-	1895	-	-	.03	6.58	.0004	.0037	.43	.0197	.0000	.07	3.2	.0229
-	1896	-	-	.03	6.52	.0005	.0035	.42	.0253	.0000	.08	3.2	.0135
-	1897	-	-	.04	6.80	.0009	.0044	.46	.0293	.0000	.08	3.2	.0675

Note to analyses of 1897: Odor of the fourth sample, faintly unpleasant; of the others, none.—The samples were collected from the reservoir.

NEWTON.

Chemical Examination of Water from Charles River, near the Pumping Station of the Newton Water Works.

[Parts per 100,000.]

Number.	Date of Collection.	Appearance.			Residue on Evaporation.		Ammonia.				Chlorine.	Nitrogen as		Oxygen Consumed.	Hardness.
		Turbidity.	Sediment.	Color.	Total.	Loss on Ignition.	Free.	Albuminoid. Total.	Albuminoid. Dissolved.	Albuminoid. Suspended.		Nitrates.	Nitrites.		
	1897.														
19536	June 22	V. slight.	V. slight.	1.58	5.10	2.95	.0008	.0380	.0350	.0030	0.25	.0000	.0000	1.27	1.4
19828	July 20	V. slight.	Slight.	1.10	6.05	2.50	.0086	.0310	.0282	.0028	0.45	.0020	.0001	0.77	2.1
20110	Aug. 16	V. slight.	V. slight.	1.50	6.10	2.85	.0046	.0348	.0328	.0020	0.46	.0030	.0002	1.22	1.8
20572	Sept. 21	Slight.	Slight.	1.20	10.60	3.70	.0042	.0386	.0344	.0042	0.60	.0020	.0001	1.02	4.0
20820	Oct. 18	Slight.	V. slight.	0.62	5.50	2.10	.0018	.0262	.0174	.0088	0.53	.0380	.0001	0.52	1.8
21311	Nov. 22	V. slight.	Slight.	1.23	7.15	3.10	.0044	.0338	.0334	.0004	0.63	.0110	.0001	1.14	2.1
21611	Dec. 20	V. slight.	V. slight.	1.24	6.20	2.70	.0034	.0322	.0316	.0006	1.00	.0290	.0001	0.96	2.3
Av..	....	....	....	1.21	6.67	2.84	.0040	.0335	.0304	.0031	0.56	.0121	.0001	0.99	2.2

Odor, generally distinctly vegetable, occasionally musty and unpleasant.

Chemical Examination of Water from the Main Underdrain of the Hyde Brook Division of the Newton Sewerage System.

[Parts per 100,000.]

Number.	Date of Collection.	Appearance.			Residue on Evaporation.	Ammonia.		Chlorine.	Nitrogen as		Oxygen Consumed.	Hardness.	Iron.
		Turbidity.	Sediment.	Color.		Free.	Albuminoid.		Nitrates.	Nitrites.			
	1897.												
18810	Mar. 18	None.	None.	.00	21.80	.0086	.0038	2.12	.6800	.0005	.03	7.8	.0000
19423	June 9	None.	V. slight.	.00	21.00	.0018	.0030	1.78	.6500	.0016	.01	7.9	.0000
20793	Oct. 13	None.	V. slight.	.03	28.20	.0098	.0114	2.48	.4800	.0060	.07	10.9	.0020

Averages by Years.

Number.	Date of Collection.	Turbidity.	Sediment.	Color.	Residue on Evaporation.	Ammonia. Free.	Ammonia. Albuminoid.	Chlorine.	Nitrates.	Nitrites.	Oxygen Consumed.	Hardness.	Iron.
-	1892	-	-	.00	27.08	.0126	.0029	3.18	1.1666	.0015	-	10.1	.0052
-	1893	-	-	.03	25.43	.0140	.0037	2.48	0.9550	.0018	.06	9.4	.0099
-	1894	-	-	.03	26.27	.0105	.0034	2.67	0.9933	.0012	.05	9.2	.0033
-	1895	-	-	.02	25.73	.0072	.0032	2.44	0.5583	.0005	.05	9.7	.0157
-	1896	-	-	.03	24.30	.0202	.0101	2.32	0.7333	.0017	.20	8.5	.0797
-	1897	-	-	.01	23.67	.0067	.0061	2.13	0.6033	.0027	.04	8.9	.0007

NOTE to analyses of 1897: Odor, none. —— The samples were collected from the underdrain, at its outlet.

NEWTON.

Chemical Examination of Water from the Main Underdrain of the Cheesecake Brook Division of the Newton Sewerage System.

[Parts per 100,000.]

Number.	Date of Collection.	Appearance.			Residue on Evaporation.	Ammonia.		Chlorine.	Nitrogen as		Oxygen Consumed.	Hardness.	Iron.
		Turbidity.	Sediment.	Color.		Free.	Albuminoid.		Nitrates.	Nitrites.			
	1897.												
18809	Mar. 18	Slight, milky	Slight.	.03	14.20	.0028	.0030	1.23	.3500	.0001	.06	5.6	.0220
19425	June 9	V. slight.	Cons., brown.	.00	18.30	.0124	.0042	1.48	.2500	.0005	.01	7.4	.0570
20792	Oct. 13	None.	Slight.	.05	15.60	.0032	.0052	1.26	.1800	.0004	.09	6.3	.0190

Averages by Years.

-	1894	-	-	.04	20.53	.0265	.0040	2.05	.5567	.0030	.05	7.9	.0340
-	1895	-	-	.03	19.30	.0125	.0038	1.50	.3167	.0004	.03	7.6	.0287
-	1896	-	-	.08	17.03	.0065	.0074	1.40	.3333	.0004	.16	6.8	.0533
-	1897	-	-	.03	16.03	.0061	.0041	1.32	.2600	.0003	.05	6.4	.0327

NOTE to analyses of 1897: Odor of the first sample, faintly unpleasant, disappearing on heating; of the others, none. —— The samples were collected from the underdrain, at its outlet.

Chemical Examination of Water from the Main Underdrain beneath the Laundry Brook Valley Sewer, Newton.

[Parts per 100,000.]

Number.	Date of Collection.	Appearance.			Residue on Evaporation.	Ammonia.		Chlorine.	Nitrogen as		Oxygen Consumed.	Hardness.	Iron.
		Turbidity.	Sediment.	Color.		Free.	Albuminoid.		Nitrates.	Nitrites.			
	1897.												
18808	Mar. 18	None.	Slight.	.02	17.90	.0128	.0026	1.86	.4500	.0002	.02	6.3	.0200
19424	June 9	V. slight.	Cons., brown.	.03	15.20	.0060	.0040	1.00	.2000	.0004	.02	6.9	.0200
20794	Oct. 13	V. slight.	V. slight.	.02	17.70	.0096	.0044	1.58	.2300	.0004	.05	6.9	.0090

Averages by Years.

-	1894	-	-	.04	17.23	.0103	.0019	1.68	.3767	.0005	.05	6.8	.0447
-	1895	-	-	.03	21.70	.0105	.0067	2.09	.6217	.0006	.04	8.5	.0550
-	1896	-	-	.02	18.40	.0118	.0017	1.88	.4600	.0005	.07	7.0	.0330
-	1897	-	-	.02	16.93	.0095	.0037	1.48	.2933	.0003	.03	6.7	.0163

NOTE to analyses of 1897: Odor of the first sample, distinctly unpleasant, disappearing on heating; of the others, none. —— The samples were collected from the underdrain, at its outlet.

NORTH ADAMS.

Water Supply of North Adams.

Chemical Examination of Water from Notch Brook Storage Reservoir, North Adams.

[Parts per 100,000.]

Number.	Date of Collection.	Appearance.			Residue on Evaporation.		Ammonia.				Chlorine.	Nitrogen as		Oxygen Consumed.	Hardness.
								Albuminoid.							
		Turbidity.	Sediment.	Color.	Total.	Loss on Ignition.	Free.	Total.	Dissolved.	Sus-pended.		Nitrates.	Nitrites.		
	1897.														
18225	Jan. 4	Slight, clayey.	Cons., dark.	.20	6.50	1.65	.0000	.0154	.0074	.0080	.09	.0100	.0001	.32	4.6
18549	Feb. 19	V. slight.	V. slight.	.05	8.30	1.45	.0010	.0040	.0038	.0002	.08	.0070	.0000	.15	5.3
19138	Apr. 26	Slight, clayey.	Slight.	.05	5.00	0.85	.0012	.0076	.0070	.0006	.09	.0030	.0000	.10	3.9
19530	June 17	None.	V. slight.	.02	6.40	0.90	.0034	.0054	.0046	.0008	.08	.0050	.0000	.06	5.0
20733	Oct. 5	V. slight.	V. slight.	.05	9.10	1.80	.0018	.0096	.0096	.0000	.08	.0030	.0000	.11	7.1
Av...	....	....	....	.07	7.06	1.33	.0015	.0084	.0065	.0019	.08	.0056	.0000	.15	5.2

Odor of the first sample, faintly vegetable, becoming faintly earthy and sweetish on heating; of the last, faintly vegetable and unpleasant, becoming distinctly vegetable on heating; of the others, none. A distinctly vegetable odor was developed in the second sample, on heating.—— The samples were collected from the reservoir.

Chemical Examination of Water from Broad Brook in Pownal, Vermont.

[Parts per 100,000.]

Number.	Date of Collection.	Appearance.			Residue on Evaporation.		Ammonia.				Chlorine.	Nitrogen as		Oxygen Consumed.	Hardness.
								Albuminoid							
		Turbidity.	Sediment.	Color.	Total.	Loss on Ignition.	Free.	Total.	Dissolved.	Sus-pended.		Nitrates.	Nitrites.		
	1897.														
18224	Jan. 4	Decided, milky.	Cons.	.09	6.85	1.25	.0000	.0160	.0040	.0120	.09	.0080	.0001	.10	4.9
18550	Feb. 19	None.	V. slight.	.07	3.40	1.00	.0002	.0082	.0082	.0000	.05	.0200	.0000	.24	2.2
19139	Apr. 28	V. slight.	V. slight.	.03	4.50	0.80	.0008	.0054	.0042	.0012	.06	.0030	.0000	.11	3.6
19531	June 21	None.	V. slight.	.18	3.20	0.90	.0006	.0042	.0040	.0002	.07	.0050	.0000	.29	1.8
20732	Oct. 5	None.	V. slight.	.07	9.00	1.50	.0006	.0044	.0028	.0016	.07	.0100	.0000	.04	7.3
Av...	....	....	....	.09	5.39	1.09	.0004	.0076	.0046	.0030	.07	.0092	.0000	.16	4.0

Odor in April and June, none; at other times, faintly vegetable.—— The samples were collected from Broad Brook, at the point where water is taken for the supply of North Adams.

Water Supply of Northampton.

Chemical Examination of Water from the Upper Storage Reservoir of the Northampton Water Works on Roberts' Meadow Brook.

[Parts per 100,000.]

Number.	Date of Collection.	Appearance.			Residue on Evaporation.		Ammonia.				Chlorine.	Nitrogen as		Oxygen Consumed.	Hardness.
		Turbidity.	Sediment.	Color.	Total.	Loss on Ignition.	Free.	Albuminoid. Total.	Albuminoid. Dissolved.	Albuminoid. Suspended.		Nitrates.	Nitrites.		
	1897.														
20676	Sept. 28	V. slight.	V. slight.	.12	4.40	1.15	.0006	.0074	.0064	.0010	.13	.0000	.0000	.16	2.3

Odor, very faintly vegetable. —— The sample was collected from the reservoir.

Chemical Examination of Water from Roberts' Meadow Brook, just above the Middle Reservoir of the Northampton Water Works.

[Parts per 100,000.]

Number.	Date of Collection.	Appearance.			Residue on Evaporation.		Ammonia.				Chlorine.	Nitrogen as		Oxygen Consumed.	Hardness.
		Turbidity.	Sediment.	Color.	Total.	Loss on Ignition.	Free.	Albuminoid. Total.	Albuminoid. Dissolved.	Albuminoid. Suspended.		Nitrates.	Nitrites.		
	1897.														
18371	Jan. 26	V. slight.	Slight.	.08	4.35	0.80	.0004	.0052	.0050	.0002	.13	.0080	.0000	.14	1.6
18631	Feb. 24	None.	Slight.	.12	4.05	1.00	.0014	.0070	.0058	.0012	.10	.0050	.0000	.26	1.6
18877	Mar. 25	V. slight.	Slight.	.33	3.45	1.20	.0006	.0104	.0090	.0014	.10	.0030	.0000	.34	0.6
19119	Apr. 26	V. slight.	Slight.	.25	3.15	1.05	.0008	.0092	.0078	.0014	.08	.0030	.0000	.19	1.3
19335	May 26	V. slight.	Slight.	.55	3.50	1.70	.0024	.0182	.0164	.0018	.07	.0050	.0000	.59	1.5
19679	June 28	V. slight.	Slight.	.18	3.65	0.65	.0008	.0054	.0054	.0000	.05	.0030	.0000	.21	1.6
19950	July 27	None.	V. slight.	.40	3.90	1.45	.0008	.0122	.0112	.0010	.08	.0050	.0000	.50	1.4
20291	Aug. 25	None.	Slight.	.42	4.30	1.60	.0008	.0134	.0124	.0010	.07	.0030	.0000	.53	1.7
20677	Sept. 28	V. slight.	V. slight.	.15	4.50	1.10	.0006	.0088	.0086	.0002	.13	.0000	.0000	.17	2.1
20990	Oct. 26	None.	V. slight.	.25	4.70	1.25	.0010	.0094	.0094	.0000	.18	.0000	.0001	.26	2.0
21360	Nov. 24	None.	Slight.	.33	4.00	1.45	.0008	.0086	.0080	.0006	.14	.0020	.0001	.30	1.8
21707	Dec. 29	V. slight.	Slight.	.10	3.40	0.55	.0004	.0032	.0032	.0000	.14	.0080	.0000	.14	1.7
Av...	....	....	....	.26	3.91	1.15	.0009	.0092	.0085	.0007	.11	.0037	.0000	.30	1.6

Odor of the last two samples, none; of the others, vegetable. —— The samples were collected from the stream, just above the reservoir.

NORTHAMPTON.

Chemical Examination of Water from the Middle Storage Reservoir of the Northampton Water Works on Roberts' Meadow Brook, collected near the Surface.

[Parts per 100,000.]

Number.	Date of Collection.	Appearance.			Residue on Evaporation.		Ammonia.				Chlorine.	Nitrogen as		Oxygen Consumed.	Hardness.
								Albuminoid.							
		Turbidity.	Sediment.	Color.	Total.	Loss on Ignition.	Free.	Total.	Dissolved.	Sus-pended.		Nitrates.	Nitrites.		
	1897.														
18372	Jan. 26	V. slight.	V. slight.	.10	5.00	1.10	.0012	.0080	.0070	.0010	.11	.0070	.0000	.18	1.6
18632	Feb. 24	V. slight.	Slight.	.15	4.05	1.50	.0012	.0090	.0074	.0016	.11	.0030	.0000	.28	2.1
18878	Mar. 25	V. slight.	V. slight	.35	3.10	0.95	.0022	.0138	.0126	.0012	.10	.0000	.0000	.35	0.6
19120	Apr. 26	V. slight.	V. slight.	.23	3.00	1.00	.0008	.0094	.0086	.0008	.10	.0000	.0000	.24	1.3
19336	May 26	V. slight.	Slight.	.38	3.45	1.45	.0038	.0164	.0146	.0018	.08	.0050	.0000	.45	1.5
19680	June 28	V. slight.	Cons.	.28	3.60	1.15	.0010	.0092	.0080	.0012	.05	.0030	.0000	.42	1.4
19951	July 27	V. slight.	Slight.	.50	3.90	1.50	.0018	.0192	.0168	.0024	.07	.0000	.0000	.68	1.6
20292	Aug. 25	None.	V. slight.	.37	4.00	1.55	.0006	.0120	.0090	.0030	.07	.0000	.0000	.43	1.6
20678	Sept. 28	V. slight.	V. slight.	.30	4.30	1.30	.0010	.0106	.0106	.0000	.11	.0000	.0000	.29	2.2
20991	Oct. 26	V. slight.	V. slight.	.30	4.80	1.50	.0010	.0134	.0114	.0020	.18	.0000	.0000	.29	1.7
21361	Nov. 24	V. slight.	Cons.	.40	4.05	1.60	.0014	.0130	.0120	.0010	.16	.0030	.0001	.48	1.8
21708	Dec. 29	V. slight.	V. slight.	.18	3.50	1.10	.0002	.0050	.0050	.0000	.14	.0070	.0000	.16	1.7
Av...	....	....	....	.29	3.90	1.31	.0013	.0116	.0103	.0013	.11	.0023	.0000	.35	1.6

Odor, faintly vegetable, sometimes none. The average amount of iron found in these samples was .0066 parts per 100,000.—— The samples were collected from the reservoir, about 1 foot beneath the surface.

Microscopical Examination of Water from the Middle Storage Reservoir of the Northampton Water Works on Roberts' Meadow Brook, collected near the Surface.

[Number of organisms per cubic centimeter.]

	1897.											
	Jan.	Feb.	Mar.	Apr.	May.	July.	July.	Aug.	Oct.	Oct.	Nov.	Dec.
Day of examination, ...	30	26	27	28	28	3	30	27	6	28	29	30
Number of sample, ...	18372	18632	18878	19120	19336	19680	19951	20292	20678	20991	21361	21708
PLANTS.												
Diatomaceæ, ...	2	2	3	32	347	214	26	7	194	78	9	8
Cyclotella, ...	0	0	0	0	6	0	0	0	140	52	0	0
Melosira, ...	0	0	0	0	64	80	0	0	0	0	0	0
Synedra, ...	2	2	1	24	248	116	6	7	30	6	7	0
Algæ, Protococcus, ...	0	0	0	0	0	0	4	0	0	74	0	0

NORTHAMPTON.

Microscopical Examination of Water from the Middle Storage Reservoir of the Northampton Water Works on Roberts' Meadow Brook, collected near the Surface — Concluded.

[Number of organisms per cubic centimeter.]

	1897.											
	Jan.	Feb.	Mar.	Apr.	May.	July.	July.	Aug.	Oct.	Oct.	Nov.	Dec.
ANIMALS.												
Infusoria,	0	0	4	2	641	39	2	15	6	56	0	0
Dinobryon,	0	0	4	0	632	39	0	15	0	50	0	0
Vermes,	0	0	0	0	2	2	2	0	0	4	2	0
Miscellaneous, Zoöglœa,	0	0	15	0	70	0	10	10	100	3	5	3
TOTAL,	2	2	22	34	1,060	255	44	32	300	215	16	11

Chemical Examination of Water from the Middle Storage Reservoir of the Northampton Water Works on Roberts' Meadow Brook, collected near the Bottom.

[Parts per 100,000.]

Number.	Date of Collection.	Appearance.			Residue on Evaporation.		Ammonia.				Chlorine.	Nitrogen as		Oxygen Consumed.	Hardness.
		Turbidity.	Sediment.	Color.	Total.	Loss on Ignition.	Free.	Albuminoid. Total.	Albuminoid. Dissolved.	Albuminoid. Suspended.		Nitrates.	Nitrites.		
	1897.														
18373	Jan. 26	Slight.	Slight.	.28	5.30	1.30	.0104	.0122	.0110	.0012	.13	.0130	.0001	.24	1.6
18633	Feb. 24	Slight.	Slight.	.28	4.70	1.35	.0050	.0100	.0088	.0012	.11	.0080	.0000	.29	2.5
18879	Mar. 25	Slight.	Slight.	.33	3.15	1.05	.0014	.0132	.0096	.0036	.10	.0030	.0000	.36	0.6
19121	Apr. 26	V. slight.	Slight.	.25	3.00	1.10	.0012	.0124	.0094	.0030	.09	.0030	.0000	.31	1.3
19337	May 26	V. slight.	Slight.	.30	3.10	1.25	.0034	.0158	.0100	.0058	.08	.0070	.0000	.32	1.5
19681	June 28	Slight.	Cons.	.62	3.40	1.65	.0050	.0160	.0122	.0038	.04	.0030	.0001	.73	1.1
19952	July 27	V. slight.	Slight.	.48	4.10	1.55	.0058	.0184	.0148	.0036	.08	.0040	.0000	.64	1.6
20293	Aug. 25	None.	V. slight.	.44	4.00	1.45	.0024	.0114	.0090	.0024	.07	.0070	.0001	.46	1.6
20679	Sept. 28	Distinct.	Cons.	.68	4.50	1.45	.0152	.0148	.0148	.0000	.08	.0000	.0000	.33	2.2
20992	Oct. 26	V. slight.	V. slight.	.30	4.45	1.30	.0020	.0134	.0132	.0002	.18	.0000	.0000	.33	1.8
21362	Nov. 24	V. slight.	Cons.	.41	4.30	1.60	.0014	.0130	.0112	.0018	.17	.0020	.0000	.48	1.7
21709	Dec. 29	Slight.	V. slight.	.32	3.35	1.00	.0028	.0090	.0080	.0010	.15	.0100	.0000	.29	1.6
Av...	....	....	....	.39	3.95	1.34	.0047	.0133	.0110	.0023	.10	.0050	.0000	.40	1.6

Odor, faintly vegetable. The average amount of iron found in these samples was .0591 parts per 100,000.

NORTH ATTLEBOROUGH.

WATER SUPPLY OF NORTH ATTLEBOROUGH.

Chemical Examination of Water from the Wells of the North Attleborough Water Works.

[Parts per 100,000.]

Number.	Date of Collection.	Appearance.			Residue on Evaporation.	Ammonia.		Chlorine.	Nitrogen as		Oxygen Consumed.	Hardness.	Iron.
		Turbidity.	Sediment.	Color.		Free.	Albuminoid.		Nitrates.	Nitrites.			
	1897.												
18514	Feb. 15	None.	None.	.00	6.30	.0004	.0018	.66	.0700	.0000	.00	2.6	.0000
19098	Apr. 20	None.	None.	.00	6.60	.0004	.0026	.62	.0500	.0000	.00	2.7	.0130
19570	June 23	None.	V. slight.	.00	6.20	.0000	.0022	.66	.0800	.0000	.02	3.0	.0000
20285	Aug. 26	None.	None.	.00	7.10	.0006	.0014	.67	.0580	.0000	.05	3.1	.0000
21006	Oct. 29	None.	None.	.02	6.50	.0016	.0024	.91	.0050	.0000	.02	3.0	.0010
Av.	....	....	....	.00	6.54	.0006	.0021	.70	.0526	.0000	.02	2.9	.0028

Odor, none. —— The samples were collected from a faucet at the pumping station.

WATER SUPPLY OF NORTHBOROUGH.

Chemical Examination of Water from the Upper Reservoir of the Northborough Water Works.

[Parts per 100,000.]

Number.	Date of Collection.	Appearance.			Residue on Evaporation.		Ammonia.				Chlorine.	Nitrogen as		Oxygen Consumed.	Hardness.
								Albuminoid.							
		Turbidity.	Sediment.	Color.	Total.	Loss on Ignition.	Free.	Total.	Dissolved.	Suspended.		Nitrates.	Nitrites.		
	1897.														
18254	Jan. 14	None.	V. slight.	1.10	5.35	2.20	.0008	.0182	.0172	.0010	.33	.0050	.0002	1.00	1.6
18646	Feb. 24	V. slight.	Slight.	0.90	4.25	1.90	.0014	.0196	.0178	.0018	.21	.0050	.0000	0.71	1.1
19128	Apr. 28	Slight.	Slight.	1.05	3.85	1.90	.0014	.0308	.0292	.0016	.20	.0000	.0001	0.92	0.6
20274	Aug. 24	V. slight.	V. slight.	0.97	4.40	1.50	.0008	.0250	.0206	.0044	.24	.0030	.0000	0.93	1.3
20961	Oct. 25	V. slight.	Slight.	0.70	4.65	1.80	.0004	.0182	.0174	.0008	.37	.0080	.0000	0.64	1.8
21676	Dec. 27	V. slight	V. slight.	1.05	4.20	1.80	.0016	.0168	.0162	.0006	.31	.0080	.0000	0.72	1.4
Av.	....	....	....	0.96	4.45	1.85	.0011	.0214	.0197	.0017	.28	.0048	.0000	0.82	1.3

Odor, distinctly vegetable and mouldy. —— The samples were collected from the reservoir.

NORTHBOROUGH.

Chemical Examination of Water from the Lower Reservoir of the Northborough Water Works.

[Parts per 100,000.]

Number.	Date of Collection.	Appearance.			Residue on Evaporation.		Ammonia.				Chlorine.	Nitrogen as		Oxygen Consumed.	Hardness.
		Turbidity.	Sediment.	Color.	Total.	Loss on Ignition.	Free.	Albuminoid. Total.	Albuminoid. Dissolved.	Albuminoid. Suspended.		Nitrates.	Nitrites.		
	1897.														
18255	Jan. 14	V. slight.	Slight.	0.75	4.15	1.60	.0026	.0180	.0174	.0006	.29	.0070	.0002	.69	1.3
18647	Feb. 24	V. slight.	V. slight.	0.73	4.20	1.85	.0010	.0154	.0154	.0000	.21	.0050	.0000	.66	0.6
19129	Apr. 28	Slight.	Slight.	0.70	3.05	1.05	.0004	.0208	.0178	.0030	.20	.0000	.0001	.60	0.8
19550	June 21	V. slight.	V. slight.	1.12	3.90	2.00	.0014	.0290	.0254	.0038	.13	.0000	.0000	.83	0.6
20275	Aug. 24	V. slight.	V. slight.	0.97	4 50	1.90	.0006	.0270	.0220	.0050	.24	.0030	.0000	.95	1.1
20962	Oct. 25	Slight	Slight.	0.65	3.80	1.55	.0008	.0198	.0142	.0056	.26	.0000	.0000	.48	1.8
21677	Dec. 27	V. slight.	V. slight.	1.00	4.10	1.65	.0014	.0170	.0166	.0004	.32	.0080	.0000	.70	1.4
Av...	....	....	....	0.85	3.96	1.66	.0012	.0210	.0184	.0026	.24	.0033	.0000	.70	1.1

Odor, distinctly vegetable. —— The samples were collected from the reservoir.

Water Supply of North Brookfield.

The advice of the State Board of Health to the board of health of North Brookfield, in regard to the quality of the public water supply of the town, may be found on pages 33 and 34 of this volume.

Chemical Examination of Water from Doane Pond, North Brookfield.

[Parts per 100,000.]

Number.	Date of Collection.	Appearance.			Residue on Evaporation.		Ammonia.				Chlorine.	Nitrogen as		Oxygen Consumed.	Hardness.
		Turbidity.	Sediment.	Color.	Total.	Loss on Ignition.	Free.	Albuminoid. Total.	Albuminoid. Dissolved.	Albuminoid. Suspended.		Nitrates.	Nitrites.		
	1897.														
18301	Jan. 20	Slight.	Slight.	.58	4.45	1.75	.0016	.0278	.0132	.0146	.20	.0050	.0001	.48	1.6
18532	Feb. 17	Distinct.	Slight.	.60	4.20	1.45	.0054	.0360	.0336	.0024	.25	.0030	.0000	.55	0.8
18844	Mar. 23	Slight.	Slight.	.30	1.35	0.40	.0028	.0252	.0166	.0086	.10	.0050	.0000	.22	0.2
19100	Apr. 22	Slight.	Slight.	.50	3.70	1.75	.0006	.0370	.0244	.0126	.15	.0030	.0000	.43	0.5
19284	May 19	Distinct.	Slight.	.55	3.15	1.40	.0034	.0290	.0246	.0044	.14	.0000	.0000	.47	0.6
19483	June 16	V. slight.	Slight.	.42	3.80	1.60	.0022	.0290	.0278	.0012	.12	.0000	.0000	.45	0.8
19866	July 22	V. slight.	V. slight.	.88	3.80	1.55	.0064	.0348	.0268	.0080	.18	.0020	.0000	.68	0.6
20325	Aug. 30	Slight.	V. slight.	.70	3.65	1.55	.0020	.0346	.0324	.0022	.12	.0030	.0000	.62	0.6
20609	Sept. 22	V. slight.	V. slight.	.70	3.65	1.75	.0010	.0326	.0318	.0008	.11	.0000	.0000	.59	0.9
20900	Oct. 20	V. slight.	V. slight.	.40	3.45	1.70	.0018	.0266	.0242	.0024	.14	.0300	.0000	.42	1.0
21286	Nov. 17	V. slight.	Slight.	.53	4.25	2.00	.0056	.0278	.0264	.0014	.20	.0030	.0001	.55	1.0
21493	Dec. 9	Decided.	Cons.	.79	3.65	1.30	.0024	.0274	.0242	.0032	.22	.0070	.0001	.54	1.4
21632	Dec. 22	Decided.	Cons.	.60	3.55	1.40	.0060	.0238	.0216	.0022	.22	.0120	.0001	.46	1.3

NORTH BROOKFIELD.

Chemical Examination of Water from Doane Pond, North Brookfield — Concluded.

Averages by Years.

[Parts per 100,000.]

Number.	Date of Collection.	Appearance.			Residue on Evaporation.		Ammonia.				Chlorine.	Nitrogen as		Oxygen Consumed.	Hardness.
								Albuminoid.							
		Turbidity.	Sediment.	Color.	Total.	Loss on Ignition.	Free.	Total.	Dissolved.	Sus-pended.		Nitrates.	Nitrites.		
-	1894	-	-	.91	4.24	1.77	.0110	.0353	.0280	.0073	.19	.0054	.0001	.62	1.1
-	1895	-	-	.51	4.92	1.60	.0076	.0365	.0285	.0080	.22	.0102	.0002	.51	1.7
-	1896	-	-	.43	3.74	1.48	.0012	.0288	.0247	.0041	.15	.0054	.0000	.51	1.1
-	1897*	-	-	.57	3.59	1.52	.0031	.0305	.0254	.0051	.16	.0053	.0000	.50	0.8

* Where more than one sample was collected in a month, the mean analysis for that month has been used in making the average.

NOTE to analyses of 1897: Odor, generally distinctly vegetable and sometimes mouldy. A faintly fishy odor was developed in some of the samples on heating. —— The samples were collected from the pond. For monthly record of height of water in this pond, see table on page 265.

Microscopical Examination of Water from Doane Pond, North Brookfield.

[Number of organisms per cubic centimeter.]

	1897.												
	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Dec.
Day of examination, ...	21	20	25	23	20	18	27	31	23	21	19	13	23
Number of sample, ...	18301	18532	18844	19100	19284	19483	19866	20325	20609	20900	21286	21493	21632
PLANTS.													
Diatomaceæ, ...	**48**	**28**	**2**	**130**	**155**	**46**	**452**	**54**	**198**	**89**	**41**	**35**	**41**
Asterionella, ...	48	0	0	0	15	0	0	6	156	8	13	23	20
Cyclotella, ...	0	0	0	0	0	0	164	0	2	1	4	1	0
Synedra, ...	0	0	0	44	32	6	120	8	40	0	10	6	12
Tabellaria, ...	0	28	2	86	108	40	168	34	0	80	11	4	7
Algæ, ...	**0**	**2**	**0**	**5**	**1**	**1**	**70**	**22**	**94**	**19**	**40**	**4**	**7**
Protococcus, ...	0	2	0	0	0	0	1	14	78	15	39	3	5
Staurastrum, ...	0	0	0	0	1	0	64	4	2	1	0	0	0
ANIMALS.													
Rhizopoda, Actinophrys, .	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**4**	**2**	**0**	**0**	**0**	**0**
Infusoria, ...	**348**	**136**	**913**	**620**	**292**	**56**	**16**	**20**	**240**	**38**	**68**	**233**	**26**
Dinobryon, ...	296	104	872	432	292	42	0	16	232	37	68	228	22
Monas, ...	52	8	0	0	0	0	0	0	0	0	0	1	0
Peridinium, ...	0	20	40	64	0	2	0	2	0	0	0	3	3
Synura, ...	0	0	0	124	0	0	0	0	0	0	0	0	0
Trachelomonas, ...	0	4	0	0	0	0	16	2	4	0	0	1	0
Vermes, ...	**0**	**4**	**0**	**0**	**4**	**6**	**0**	**0**	**0**	**0**	**0**	**1**	**2**
Crustacea, ...	**0**	**0**	**0**	**0**	**0**	**pr.**	**pr.**	**0**	**pr.**	**0**	**pr.**	**0**	**0**
Miscellaneous, Zoöglœa, . .	**10**	**50**	**10**	**40**	**120**	**80**	**300**	**15**	**5**	**5**	**5**	**5**	**40**
TOTAL, ...	406	220	925	795	572	189	882	115	539	151	154	278	116

NORTH BROOKFIELD.

Chemical Examination of Water from the Filtered-water Well of the North Brookfield Water Works.

[Parts per 100,000.]

Number.	Date of Collection.	Appearance.			Residue on Evaporation.		Ammonia.				Chlorine.	Nitrogen as		Oxygen Consumed.	Hardness.
		Turbidity.	Sediment.	Color.	Total.	Loss on Ignition.	Free.	Albuminoid. Total.	Albuminoid. Dissolved.	Albuminoid. Suspended.		Nitrates.	Nitrites.		
	1897.														
18302	Jan. 20	V. slight.	V. slight.	.58	3.90	1.70	.0018	.0244	.0228	.0016	.20	.0030	.0000	.50	1.4
18534	Feb. 17	Slight.	Slight.	.50	4.15	1.40	.0024	.0216	.0208	.0008	.20	.0130	.0000	.52	0.9
18845	Mar. 23	Distinct.	V. slight.	.63	3.90	1.00	.0104	.0216	.0184	.0032	.18	.0050	.0003	.47	0.9
19101	Apr. 22	V. slight.	V. slight.	.38	3.40	1.20	.0020	.0220	.0194	.0026	.16	.0050	.0001	.32	0.9
19286	May 19	Slight.	Slight.	.55	3.35	1.40	.0010	.0270	.0218	.0052	.12	.0030	.0000	.55	0.6
19484	June 16	V. slight.	V. slight.	.38	3.65	1.45	.0014	.0264	.0246	.0018	.11	.0020	.0001	.46	0.8
19867	July 22	Slight.	V. slight.	.88	4.05	1.70	.0030	.0282	.0252	.0030	.16	.0020	.0000	.67	1.1
20326	Aug. 30	V. slight.	V. slight.	.68	3.65	1.55	.0020	.0280	.0248	.0032	.14	.0000	.0000	.57	1.0
20610	Sept. 21	V. slight.	V. slight.	.68	3.35	1.60	.0012	.0280	.0230	.0050	.12	.0000	.0000	.56	0.8
20901	Oct. 20	V. slight.	V. slight.	.60	3.70	1.55	.0002	.0250	.0248	.0002	.14	.0380	.0000	.58	1.0
21288	Nov. 17	V. slight.	V. slight.	.59	3.45	1.80	.0040	.0252	.0222	.0030	.20	.0070	.0000	.56	1.0
21494	Dec. 9	Decided.	Cons.	.49	3.80	1.40	.0016	.0242	.0206	.0036	.22	.0100	.0001	.42	1.4
21633	Dec. 22	Decided.	V. slight.	.63	3.40	1.30	.0040	.0174	.0170	.0004	.20	.0150	.0001	.42	1.1

Averages by Years.

-	1894	-	-	.73	4.68	1.86	.0096	.0286	.0252	.0034	.19	.0095	.0002	.54	1.6
-	1895	-	-	.37	5.13	1.50	.0137	.0255	.0196	.0059	.21	.0089	.0001	.37	1.9
-	1896	-	-	.42	3.58	1.37	.0022	.0229	.0200	.0029	.15	.0070	.0001	.48	1.0
-	1897*	-	-	.58	3.68	1.47	.0027	.0248	.0222	.0026	.16	.0075	.0000	.51	1.0

* Where more than one sample was collected in a month, the mean analysis for that month has been used in making the average.

Note to analyses of 1897: Odor, generally distinctly vegetable. —— The samples were collected from the filtered-water well in Doane Pond, from which the supply of the town is drawn.

NORTH BROOKFIELD.

Microscopical Examination of Water from the Filtered-water Well of the North Brookfield Water Works.

[Number of organisms per cubic centimeter.]

	1897.												
	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Dec.
Day of examination,	21	20	25	23	20	18	27	31	23	21	19	13	23
Number of sample,	18302	18534	18845	19101	19286	19484	19867	20326	20610	20901	21288	21494	21633
PLANTS.													
Diatomaceæ,	24	7	6	5	88	146	252	52	66	36	26	24	39
Asterionella,	16	5	2	5	30	16	0	16	50	6	4	0	9
Cyclotella,	0	1	0	0	0	0	80	0	10	0	4	0	0
Synedra,	2	0	1	0	28	14	96	6	6	2	8	21	15
Tabellaria,	6	1	3	0	30	116	176	30	0	28	10	3	15
Cyanophyceæ, Merismopœdia,	0	0	0	0	0	0	0	0	0	0	8	0	0
Algæ,	0	0	0	0	10	14	95	6	30	13	10	1	5
Staurastrum,	0	0	0	0	0	0	88	2	0	1	0	0	0
ANIMALS.													
Rhizopoda, Actinophrys,	0	0	0	0	0	0	0	4	0	0	0	0	0
Infusoria,	13	78	16	92	362	143	9	54	28	28	39	129	8
Dinobryon,	5	68	1	56	360	136	1	44	24	26	38	124	5
Peridinium,	8	9	15	32	0	0	0	2	0	1	0	4	3
Vermes,	0	0	0	2	0	1	1	0	2	0	0	1	0
Miscellaneous, Zoöglœa,	5	70	10	20	80	120	300	20	0	5	5	15	10
TOTAL,	42	155	32	119	540	424	657	136	126	82	88	170	62

Chemical Examination of Water from North Pond, North Brookfield.

[Parts per 100,000.]

Number.	Date of Collection.	Appearance.			Residue on Evaporation.		Ammonia.				Chlorine.	Nitrogen as		Oxygen Consumed.	Hardness.
								Albuminoid.							
		Turbidity.	Sediment.	Color.	Total.	Loss on Ignition.	Free.	Total.	Dissolved.	Suspended.		Nitrates.	Nitrites.		
	1897.														
18533	Feb. 17	Distinct.	Slight.	.50	4.85	1.85	.0038	.0466	.0358	.0108	.26	.0050	.0000	.66	0.9
19285	May 19	Distinct.	Slight.	.53	2.65	1.10	.0002	.0234	.0208	.0026	.13	.0030	.0000	.58	0.5
20324	Aug. 30	Slight.	Slight.	.67	3.45	1.60	.0042	.0318	.0256	.0062	.12	.0020	.0000	.81	0.8
21287	Nov. 17	Slight.	Slight.	.56	3.65	1.95	.0038	.0304	.0266	.0038	.16	.0070	.0001	.66	1.0
Av.	....	....	....	.56	3.65	1.62	.0030	.0330	.0272	.0058	.17	.0042	.0000	.68	0.8

Odor, distinctly vegetable; of the first sample, also unpleasant. A distinctly fishy odor was developed in the first sample, on heating. —— The samples were collected from the pond.

NORTH BROOKFIELD.

Microscopical Examination of Water from North Pond, North Brookfield.

[Number of organisms per cubic centimeter.]

	1897.			
	February.	May.	August.	November.
Day of examination,	20	20	31	19
Number of sample,	18533	19285	20324	21287
PLANTS.				
Diatomaceæ,	52	2,000	770	457
Asterionella,	50	440	0	15
Synedra,	2	328	6	0
Tabellaria,	0	1,232	760	440
Cyanophyceæ,	0	2	22	4
Merismopœdia,	0	0	22	4
Algæ,	2	12	140	112
Protococcus,	0	0	108	24
Raphidium,	2	4	16	76
ANIMALS.				
Rhizopoda, Actinophrys,	0	2	8	0
Infusoria,	598	64	26	0
Dinobryon,	21	56	0	0
Mallomonas,	0	2	20	0
Peridinium,	576	0	0	0
Vermes,	4	1	2	0
Crustacea, Cyclops,	0	0	pr.	pr.
Miscellaneous, Zoöglœa,	4	100	25	10
TOTAL,	660	2,181	993	583

Table showing Heights of Water in Doane Pond on the First of Each Month in 1897.

[High-water, 14.50 feet.]

DATE — 1897.	Feet.	DATE — 1897.	Feet.
Jan. 1,	11.58	July 1,	13.58
Feb. 1,	11.00	Aug 1,	14.50
March 1,	11.00	Sept. 1,	13.83
April 1,	14.50	Oct. 1,	13.33
May 1,	13.50	Nov. 1,	13.17
June 1,	11.00	Dec. 1,	13.50

NORWOOD.

Water Supply of Norwood.

Chemical Examination of Water from Buckmaster Pond, Dedham.

[Parts per 100,000.]

Number.	Date of Collection.	Appearance.			Residue on Evaporation.		Ammonia.				Chlorine.	Nitrogen as		Oxygen Consumed.	Hardness.
		Turbidity.	Sediment.	Color.	Total.	Loss on Ignition.	Free.	Albuminoid. Total.	Albuminoid. Dissolved.	Albuminoid. Suspended.		Nitrates.	Nitrites.		
	1897.														
18248	Jan. 13	V. slight.	V. slight.	.10	3.40	1.30	.0106	.0152	.0144	.0008	.43	.0100	.0001	.17	0.6
18423	Feb. 2	V. slight.	V. slight.	.10	2.75	0.70	.0078	.0112	.0110	.0002	.37	.0150	.0000	.20	0.6
18695	Mar. 2	V. slight.	V slight.	.08	2.90	0.90	.0064	.0132	.0112	.0020	.38	.0070	.0000	.22	0.5
18720	Mar. 8	V. slight.	V. slight.	.10	2.60	0.75	.0030	.0174	.0130	.0044	.38	.0070	.0000	.18	0.9
18940	Mar. 31	Distinct.	V. slight.	.08	2.60	1.40	.0006	.0142	.0106	.0036	.38	.0070	.0000	.30	0.3
19186	May 6	V. slight.	Slight.	.20	2.90	0.95	.0002	.0176	.0176	.0000	.36	.0030	.0000	.28	0.5
19372	June 2	V. slight.	V. slight.	.25	2.80	1.20	.0016	.0188	.0170	.0018	.17	.0030	.0000	.29	0.4
19716	July 6	V. slight.	V. slight.	.17	2.60	0.95	.0014	.0206	.0184	.0022	.38	.0030	.0000	.27	0.5
19986	Aug. 3	V. slight.	V. slight.	.11	2.35	1.20	.0012	.0214	.0194	.0020	.32	.0050	.0000	.29	0.3
20390	Sept. 7	V. slight.	V. slight.	.10	2.60	1.25	.0006	.0246	.0184	.0062	.37	.0020	.0000	.25	0.5
20690	Oct. 5	V. slight.	V. slight.	.15	2.90	1.35	.0010	.0212	.0188	.0024	.40	.0000	.0000	.23	0.9
21037	Nov. 2	V. slight.	V. slight.	.10	2.80	1.25	.0038	.0194	.0194	.0000	.40	.0000	.0000	.23	0.8
21444	Dec. 6	V. slight.	Slight.	.14	3.10	1.10	.0114	.0222	.0198	.0024	.40	.0100	.0001	.18	0.8
Av.*	....	....	....	.13	2.80	1.12	.0037	.0185	.0164	.0021	.36	.0054	.0000	.24	0.6

* Where more than one sample was collected in a month, the mean analysis for that month has been used in making the average.

Odor, faintly vegetable, becoming stronger on heating. A fishy odor was developed in the samples collected in March. —— The samples were collected from the pond. For monthly record of height of water in this pond, see page 267.

Microscopical Examination of Water from Buckmaster Pond, Dedham.

[Number of organisms per cubic centimeter.]

	1897.												
	Jan.	Feb.	Mar.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov	Dec.
Day of examination, . . .	13	5	5	9	2	8	5	7	4	8	6	3	6
Number of sample, . . .	18248	18423	18695	18720	18940	19186	19372	19716	19986	20390	20690	21037	21444
PLANTS.													
Diatomaceæ, ...	**0**	**50**	**1,045**	**0**	**77**	**32**	**3**	**4**	**6**	**2**	**18**	**3**	**21**
Asterionella, ...	0	44	1,044	0	76	0	0	0	0	0	8	0	9
Cyanophyceæ, ...	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**2**	**0**	**2**	**21**	**1**	**0**
Cœlosphærium, ...	0	0	0	0	0	0	0	0	0	2	12	1	0
Algæ, ...	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**2**	**23**	**4**	**13**	**0**	**0**

NORWOOD.

Microscopical Examination of Water from Buckmaster Pond, Dedham — Concluded.

[Number of organisms per cubic centimeter.]

	1897.												
	Jan.	Feb.	Mar.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
ANIMALS.													
Rhizopoda, Difflugia, . .	0	0	0	0	0	0	0	0	0	0	1	0	0
Infusoria, ...	52	112	5	1,716	2,708	130	0	0	0	0	0	0	3
Dinobryon, ...	52	112	2	1,716	2,708	124	0	0	0	0	0	0	0
Miscellaneous, Zoöglœa, . .	0	25	10	0	5	20	0	0	0	3	5	0	10
TOTAL, ...	52	187	1,060	1,716	2,790	182	3	8	29	11	58	4	34

Table showing Heights of Water in Buckmaster Pond on the First of Each Month in 1897.

[Distance below crest of dam.]

DATE — 1897.	Feet.	DATE — 1897.	Feet.
Jan. 1, ...	3.00	July 1, ...	3.67
Feb. 1, ...	2.62	Aug. 1, ...	4.83
March 1, ...	2.17	Sept. 1, ...	5.58
April 1, ...	1.42	Oct. 1, ...	6.31
May 1, ...	0.00	Nov. 1, ...	6.75
June 1, ...	1.42	Dec. 1, ...	5.00

WATER SUPPLY OF ORANGE.

Chemical Examination of Water from North Pond, Orange.

[Parts per 100,000.]

Number.	Date of Collection.	Appearance.			Residue on Evaporation.		Ammonia.				Chlorine.	Nitrogen as		Oxygen Consumed.	Hardness.
								Albuminoid.							
		Turbidity.	Sediment.	Color.	Total.	Loss on Ignition.	Free.	Total.	Dissolved.	Sus-pended.		Nitrates.	Nitrites.		
	1897.														
20154	Aug. 18	V. slight.	V. slight.	.34	2.60	1.20	.0020	.0174	.0144	.0030	.10	.0020	.0000	.43	0.6
20573	Sept. 20	V. slight.	V. slight.	.32	2.55	1.50	.0006	.0206	.0184	.0022	.10	.0030	.0000	.48	0.5
20880	Oct. 18	V. slight.	V. slight.	.40	2.45	1.20	.0010	.0226	.0172	.0054	.13	.0030	.0000	.43	0.6
21277	Nov. 16	V. slight.	Decided.	.39	2.95	1.75	.0014	.0202	.0158	.0044	.12	.0020	.0001	.42	0.6
21627	Dec. 21	Slight.	Cons., earthy.	.30	3.20	0.90	.0010	.0154	.0102	.0052	.18	.0110	.0000	.30	0.8
Av...	....	....	....	.35	2.75	1.31	.0012	.0192	.0152	.0040	.13	.0042	.0000	.41	0.6

Odor, distinctly vegetable. —— The samples were collected from the pond.

ORANGE.

Chemical Examination of Water from the Distributing Reservoir of the Orange Water Works.

[Parts per 100,000.]

Number.	Date of Collection.	Appearance.			Residue on Evaporation.		Ammonia.				Chlorine.	Nitrogen as		Oxygen Consumed.	Hardness.
		Turbidity.	Sediment.	Color.	Total.	Loss on Ignition.	Free.	Albuminoid. Total.	Albuminoid. Dissolved.	Albuminoid. Sus-pended.		Nitrates.	Nitrites.		
	1897.														
19734	July 6	None.	V. slight.	.05	2.80	0.55	.0012	.0054	.0040	.0014	.11	.0000	.0000	.11	0.5
20155	Aug. 18	None.	V. slight.	.07	2.75	0.80	.0006	.0026	.0020	.0006	.11	.0020	.0000	.11	0.6
20574	Sept. 20	None.	V. slight.	.02	2.75	0.70	.0004	.0014	.0010	.0004	.10	.0000	.0000	.09	0.8
20881	Oct. 18	None.	V slight.	.05	2.90	0.75	.0002	.0030	.0030	.0000	.13	.0180	.0000	.08	0.6
21278	Nov. 16	Slight.	Cons.	.20	2.85	0.60	.0002	.0048	.0046	.0002	.11	.0000	.0000	.17	1.0
21628	Dec. 21	None.	V. slight.	.10	3.10	0.70	.0008	.0056	.0056	.0000	.14	.0030	.0000	.11	0.8
Av...	....	....	....	.08	2.86	0.67	.0006	.0038	.0034	.0004	.12	.0038	.0000	.11	0.7

Odor, faintly vegetable or none. —— The samples were collected from the reservoir.

Water Supply of Palmer Fire District, Palmer. — Palmer Water Company.

Chemical Examination of Water from the Lower Reservoir of the Palmer Water Company.

[Parts per 100,000.]

Number.	Date of Collection.	Appearance.			Residue on Evaporation.		Ammonia.				Chlorine.	Nitrogen as		Oxygen Consumed.	Hardness.
		Turbidity.	Sediment.	Color.	Total.	Loss on Ignition.	Free.	Albuminoid. Total.	Albuminoid. Dissolved.	Albuminoid. Sus-pended.		Nitrates.	Nitrites.		
	1897.														
18380	Jan. 27	V. slight, milky.	Slight.	.18	3.55	0.95	.0014	.0104	.0094	.0010	.14	.0050	.0000	.24	0.8
18705	Mar. 4	V. slight.	V. slight.	.33	2.80	1.00	.0004	.0074	.0074	.0000	.11	.0050	.0000	.35	0.5
18846	Mar. 23	V slight.	V. slight.	.30	2.80	0.65	.0008	.0102	.0086	.0016	.11	.0030	.0001	.22	0.5
19137	Apr. 28	None.	V. slight.	.25	2.55	0.65	.0020	.0134	.0118	.0016	.11	.0030	.0000	.24	0.5
19334	May 27	V. slight.	V. slight.	.47	2.80	1.20	.0012	.0190	.0182	.0008	.08	.0030	.0000	.46	1.0
19544	June 22	V. slight.	Slight.	.37	3.45	1.40	.0012	.0146	.0110	.0036	.07	.0050	.0000	.29	0.8
19937	July 27	None.	V. slight.	.50	4.00	1.35	.0006	.0118	.0096	.0022	.15	.0050	.0000	.52	1.1
20323	Aug. 30	Slight.	V. slight.	.31	3.75	1.00	.0014	.0086	.0062	.0024	.10	.0000	.0000	.25	1.0
20670	Sept. 29	V. slight	V. slight.	.23	3.35	1.05	.0006	.0064	.0052	.0012	.11	.0020	.0000	.15	1.4
20985	Oct. 27	V. slight.	V. slight.	.23	3.60	0.70	.0020	.0060	.0060	.0000	.15	.0050	.0001	.14	1.0
21339	Nov. 23	Slight.	Cons.	.40	3.35	1.15	.0008	.0110	.0104	.0006	.15	.0040	.0000	.32	1.1
21716	Dec. 30	V. slight	V. slight.	.29	3.20	0.85	.0018	.0070	.0062	.0008	.18	.0060	.0000	.23	1.4
Av...	....	....	....	.32	3.27	1.00	.0012	.0105	.0092	.0013	.12	.0038	.0000	.28	0.9

Odor, generally faintly vegetable. —— The first sample was collected from the reservoir, and the remaining samples from a faucet in the town.

PALMER.

Microscopical Examination of Water from the Lower Reservoir of the Palmer Water Company.

[Number of organisms per cubic centimeter.]

	1897.											1898.
	Jan.	Mar.	Mar.	Apr.	May.	June.	July.	Aug.	Oct.	Oct.	Nov.	Jan.
Day of examination,	30	6	25	30	28	23	30	31	4	28	24	3
Number of sample,	18380	18705	18846	19137	19334	19544	19937	20323	20670	20985	21339	21716
PLANTS.												
Diatomaceæ,	22	360	8	6	59	60	14	16	6	0	13	1
Asterionella,	0	348	0	0	0	0	0	0	0	0	0	0
ANIMALS.												
Rhizopoda,	0	0	0	1	0	0	0	1	0	0	0	0
Infusoria,	4	0	20	0	14	293	0	1	3	0	22	0
Dinobryon,	0	0	20	0	14	292	0	0	2	0	22	0
Vermes,	2	0	0	0	1	1	0	0	1	0	1	0
Miscellaneous, Zoöglœa,	5	0	5	0	0	0	0	10	20	0	8	5
TOTAL,	33	360	33	7	74	354	14	28	30	0	44	6

WATER SUPPLY OF PEABODY.

Chemical Examination of Water from Brown's Pond, Peabody.

[Parts per 100,000.]

Number.	Date of Collection.	Appearance.			Residue on Evaporation.		Ammonia.				Chlorine.	Nitrogen as		Oxygen Consumed.	Hardness.
								Albuminoid.							
		Turbidity.	Sediment.	Color.	Total.	Loss on Ignition.	Free.	Total.	Dissolved.	Sus-pended.		Nitrates.	Nitrites.		
	1897.														
18726	Mar. 9	V. slight.	V. slight.	.10	3.20	0.85	.0000	.0176	.0148	.0028	.60	.0030	.0001	.23	0.5
19455	June 14	Slight.	Slight.	.20	2.80	0.75	.0006	.0162	.0126	.0036	.53	.0100	.0000	.35	0.5
20474	Sept. 14	V. slight.	Slight.	.18	3.25	1.65	.0002	.0178	.0164	.0014	.56	.0020	.0000	.33	0.9
21524	Dec. 14	Slight.	Slight.	.10	2.70	1.10	.0014	.0194	.0148	.0046	.62	.0070	.0000	.22	1.0
Av...	....	....	....	.14	2.99	1.09	.0005	.0177	.0146	.0031	.58	.0055	.0000	.28	0.7

Odor, vegetable. A faintly fishy odor was developed in the first sample on heating. —— The samples were collected from the pond.

PEABODY.

Chemical Examination of Water from Spring Pond, Peabody.

[Parts per 100,000.]

Number.	Date of Collection.	Appearance.			Residue on Evaporation.		Ammonia.				Chlorine.	Nitrogen as		Oxygen Consumed.	Hardness.
		Turbidity.	Sediment.	Color.	Total.	Loss on Ignition.	Free.	Albuminoid. Total.	Albuminoid. Dissolved.	Albuminoid. Suspended.		Nitrates.	Nitrites.		
	1897.														
18725	Mar. 9	V slight.	Slight.	.05	3.55	1.15	.0058	.0130	.0096	.0034	.79	.0000	.0000	.18	0.9
19456	June 14	Slight.	Slight.	.03	3.50	0.60	.0004	.0136	.0096	.0040	.66	.0050	.0000	.16	1.4
20475	Sept. 14	V. slight.	Slight.	.03	3.60	1.25	.0002	.0124	.0116	.0008	.70	.0020	.0000	.17	1.4
21523	Dec. 14	V. slight.	Cons.	.06	3.55	1.35	.0022	.0278	.0150	.0128	.78	.0070	.0000	.12	1.6
Av...	....	....	....	.04	3.55	1.09	.0021	.0167	.0114	.0053	.73	.0035	.0000	.16	1.3

Odor, faintly vegetable; of the last sample, also musty.—— The samples were collected from the pond.

Chemical Examination of Water from the Lower Basin, Peabody Water Works.

[Parts per 100,000.]

Number.	Date of Collection.	Appearance.			Residue on Evaporation.		Ammonia.				Chlorine.	Nitrogen as		Oxygen Consumed.	Hardness.
		Turbidity.	Sediment.	Color.	Total.	Loss on Ignition.	Free.	Albuminoid. Total.	Albuminoid. Dissolved.	Albuminoid. Suspended.		Nitrates.	Nitrites.		
	1897.														
18727	Mar. 9	V. slight.	V. slight.	.05	5.05	1.50	.0002	.0080	.0080	.0000	.80	.0600	.0002	.07	2.2
19457	June 14	None.	Slight.	.03	4.75	1.10	.0024	.0128	.0100	.0028	.73	.0470	.0004	.17	2.1
20522	Sept. 17	V. slight.	V. slight.	.06	–	–	.0018	.0124	.0110	.0014	.80	.0250	.0000	–	2.7
21522	Dec. 14	V. slight.	Slight.	.05	5.20	1.85	.0024	.0108	.0092	.0016	.84	.0600	.0003	.07	2.3
Av...	....	....	....	.05	5.00	1.48	.0017	.0110	.0095	.0015	.79	.0480	.0002	.10	2.3

Odor, vegetable; of the last sample, musty. A fishy odor was developed in the first sample on heating.—— The samples were collected from the basin, and represent a mixture of the water from Spring and Brown's ponds.

Pembroke.

Chemical Examination of Water from Silver Lake, in Pembroke, collected at the Surface.

[Parts per 100,000.]

Number.	Date of Collection.	Appearance.			Residue on Evaporation.		Ammonia.				Chlorine.	Nitrogen as		Oxygen Consumed.	Hardness.
		Turbidity.	Sediment.	Color.	Total.	Loss on Ignition.	Free.	Albuminoid. Total.	Albuminoid. Dissolved.	Albuminoid. Sus-pended.		Nitrates.	Nitrites.		
	1897.														
18317	Jan. 20	V. slight.	V. slight.	.10	3.75	1.95	.0006	.0118	.0110	.0008	.62	.0000	.0000	.21	0.6
20144	Aug. 18	V. slight.	V. slight.	.13	2.95	0.80	.0010	.0126	.0106	.0020	.65	.0020	.0000	.22	0.6
20146	Aug. 18	V. slight.	None.	.14	3.05	1.00	.0008	.0138	.0118	.0020	.64	.0020	.0000	.22	0.6
21051	Nov. 4	None.	V. slight.	.12	2.90	1.05	.0006	.0130	.0130	.0000	.64	.0000	.0000	.22	0.8
21086	Nov. 8	V. slight.	Cons.	.08	3.10	1.10	.0006	.0136	.0132	.0004	.66	.0000	.0000	.22	1.0
21292	Nov. 17	V. slight.	Cons.	.12	3.35	1.20	.0004	.0136	.0112	.0024	.66	.0020	.0000	.18	0.8
21344	Nov. 23	None.	Cons.	.12	3.15	1.00	.0008	.0134	.0120	.0014	.62	.0040	.0000	.20	1.1
21456	Dec. 6	V. slight.	Slight.	.11	3.10	0.95	.0002	.0140	.0120	.0020	.68	.0020	.0000	.19	1.0
21599	Dec. 20	V. slight.	Slight.	.15	2.65	1.00	.0004	.0114	.0104	.0010	.68	.0030	.0000	.19	1.0
Av.*.	....	....	....	.12	3.18	1.23	.0006	.0128	.0114	.0014	.64	.0016	.0000	.20	0.8

* Where more than one sample was collected in a month, the mean analysis for that month has been used in making the average.

Odor of No. 21599, none; of Nos. 21051 and 21456, none, becoming faintly vegetable on heating; of the others, faintly vegetable, sometimes becoming stronger on heating. The quantity of iron was determined in these samples, but was found to be insignificant. —— The samples were collected as follows: No. 18317, from the lake at its outlet; No. 20146, from the southern part of the lake, opposite Silver Lake Grove; the remaining samples, from the northerly part of the lake, off Gunners' Point. The analyses of samples of water from Silver Lake were made in connection with an investigation for an additional water supply for the city of Brockton.

Chemical Examination of Water from Silver Lake, in Pembroke, collected 20 Feet beneath the Surface.

[Parts per 100,000.]

Number.	Date of Collection.	Appearance.			Residue on Evaporation.		Ammonia.				Chlorine.	Nitrogen as		Oxygen Consumed.	Hardness.
		Turbidity.	Sediment.	Color.	Total.	Loss on Ignition.	Free.	Albuminoid. Total.	Albuminoid. Dissolved.	Albuminoid. Sus-pended.		Nitrates.	Nitrites.		
	1897.														
21052	Nov. 4	V. slight.	Slight.	.09	3.10	1.10	.0002	.0130	.0056	.0074	.64	.0000	.0000	.25	0.8
21087	Nov. 8	V. slight.	Cons.	.10	3.10	1.10	.0002	.0134	.0126	.0008	.66	.0020	.0000	.23	1.3
21293	Nov. 17	V. slight.	Cons.	.09	3.20	1.15	.0004	.0134	.0114	.0020	.68	.0020	.0000	.18	0.6
21345	Nov. 23	V. slight.	Cons.	.10	3.25	1.05	.0010	.0140	.0130	.0010	.66	.0010	.0000	.20	1.0
21457	Dec. 6	V. slight.	Slight.	.11	3.10	0.90	.0002	.0136	.0128	.0008	.72	.0020	.0000	.18	1.0
21600	Dec. 20	V. slight.	Slight.	.13	2.70	1.10	.0002	.0116	.0096	.0020	.68	.0010	.0000	.21	1.0

Odor of No. 21600, none; of Nos. 21052 and 21457, none, becoming faintly vegetable on heating; of the others, faintly vegetable, becoming somewhat stronger on heating. The quantity of iron was determined in these samples, but was found to be insignificant. —— The samples were collected from the lake, off Gunners' Point.

PEMBROKE.

Chemical Examination of Water from Silver Lake, in Pembroke, collected 40 Feet beneath the Surface.

[Parts per 100,000.]

Number.	Date of Collection.	Appearance.			Residue on Evaporation.		Ammonia.				Chlorine.	Nitrogen as		Oxygen Consumed.	Hardness.
								Albuminoid							
		Turbidity.	Sediment.	Color.	Total.	Loss on Ignition.	Free.	Total.	Dissolved.	Sus-pended.		Nitrates.	Nitrites.		
	1897.														
21053	Nov. 4	None.	V. slight.	.09	3.30	1.25	.0012	.0162	.0134	.0028	.64	.0000	.0000	.26	0.8
21088	Nov. 8	V. slight.	Cons.	.11	3.20	1.10	.0004	.0132	.0108	.0024	.69	.0020	.0000	.26	1.3
21294	Nov. 17	V. slight.	Cons.	.11	3.15	1.10	.0006	.0142	.0126	.0016	.66	.0020	.0000	.17	0.6
21346	Nov. 23	V. slight.	Cons.	.07	3.15	1.05	.0006	.0158	.0132	.0026	.68	.0020	.0000	.21	1.0
21458	Dec. 6	V. slight.	Slight.	.11	3.10	0.90	.0000	.0156	.0124	.0032	.70	.0020	.0000	.18	1.3
21601	Dec. 20	V. slight.	Slight.	.18	2.80	1.00	.0004	.0114	.0092	.0022	.68	.0040	.0000	.20	1.0

Odor of Nos. 21294 and 21346, faintly vegetable; of the others, none, becoming faintly vegetable on heating. The quantity of iron was determined in these samples, but was found to be insignificant. —— The samples were collected from the lake, off Gunners' Point.

Chemical Examination of Water from Silver Lake, in Pembroke, collected near the Bottom.

[Parts per 100,000.]

Number.	Date of Collection.	Appearance.			Residue on Evaporation.		Ammonia.				Chlorine.	Nitrogen as		Oxygen Consumed.	Hardness.
								Albuminoid.							
		Turbidity.	Sediment.	Color.	Total.	Loss on Ignition.	Free.	Total.	Dissolved.	Sus-pended.		Nitrates.	Nitrites.		
	1897.														
20145	Aug. 18	Distinct.	V. slight.	.18	3.95	1.15	.0024	.0112	.0092	.0020	.64	.0020	.0000	.25	1.1
20147	Aug. 18	Distinct.	Slight.	.45	4.05	1.25	.0104	.0132	.0102	.0030	.66	.0020	.0000	.29	1.1
21054	Nov. 4	V. slight.	Slight.	.11	3.25	1.20	.0008	.0150	.0148	.0002	.66	.0000	.0000	.26	0.8
21089	Nov. 8	V. slight.	Cons.	.12	3.10	1.00	.0002	.0142	.0118	.0024	.64	.0030	.0000	.19	1.0
21295	Nov. 17	V. slight.	Cons.	.10	3.05	1.00	.0008	.0142	.0120	.0022	.66	.0020	.0000	.17	0.8
21347	Nov. 23	V. slight.	Cons.	.10	3.10	0.90	.0012	.0152	.0134	.0018	.65	.0000	.0000	.21	1.0
21459	Dec. 6	V. slight.	Cons.	.10	3.00	0.85	.0006	.0154	.0136	.0018	.68	.0020	.0000	.18	1.3
21602	Dec. 20	V. slight.	Cons.	.11	2.85	1.00	.0004	.0110	.0098	.0012	.68	.0020	.0000	.21	1.0

Odor of Nos. 21054, 21459 and 21602, none, becoming faintly vegetable on heating; of the others, faintly vegetable, becoming somewhat stronger on heating. No. 20147 contained .2000 parts per 100,000 of iron; the quantity found in the other samples was insignificant. —— The samples were collected from the lake, off Gunners' Point, at depths ranging from 50 to 67 feet beneath the surface.

PEMBROKE.

Chemical Examination of Water from Brooks in the Vicinity of Silver Lake, in Pembroke and Kingston.

[Parts per 100,000.]

Number.	Date of Collection.	Appearance.			Residue on Evaporation.		Ammonia.				Chlorine.	Nitrogen as		Oxygen Consumed.	Hardness.
								Albuminoid.							
		Turbidity.	Sediment.	Color.	Total.	Loss on Ignition.	Free.	Total.	Dissolved.	Suspended.		Nitrates.	Nitrites.		
	1897.														
20148	Aug.18	Slight.	Slight.	1.50	4.70	2.05	.0014	.0260	.0216	.0044	.74	.0020	.0000	1.06	0.5
20149	Aug.18	V. slight.	V. slight.	2.20	5.60	3.10	.0012	.0338	.0290	.0048	.87	.0000	.0000	1.74	0.6
20549	Sept.16	None.	Slight.	0.30	4.10	1.10	.0004	.0162	.0132	.0030	.70	.0030	.0000	0.30	0.9
20550	Sept.16	None.	V. slight.	0.30	3.80	1.10	.0000	.0136	.0128	.0008	.75	.0020	.0000	0.41	0.8

Odor, faintly vegetable. —— The samples were collected as follows: No. 20148, from Pine Brook, at a mill pond about a mile above its confluence with Jones River; No. 20149, from a pond on Howard Brook, about half a mile above its confluence with the stream flowing from Silver Lake; No. 20549, from Herring Brook, near Pembroke Centre, and above its confluence with Little Pudding Brook; No. 20550, from Jones River, just below its confluence with Pine Brook.

Pepperell.

The advice of the State Board of Health to the town of Pepperell, with reference to a proposed water supply for that town, may be found on pages 34 to 36 of this volume.

Water Supply of Pittsfield.

Chemical Examination of Water from Sacket Brook Reservoir, Pittsfield.

[Parts per 100,000.]

Number.	Date of Collection.	Appearance.			Residue on Evaporation.		Ammonia.				Chlorine.	Nitrogen as		Oxygen Consumed.	Hardness.
								Albuminoid.							
		Turbidity.	Sediment.	Color.	Total.	Loss on Ignition.	Free.	Total.	Dissolved.	Suspended.		Nitrates.	Nitrites.		
	1897.														
18858	Mar. 23	Slight.	Cons.	.23	4.45	1.05	.0012	.0112	.0084	.0028	.07	.0080	.0000	.28	2.9
19548	June 22	None.	V. slight.	.05	6.85	1.15	.0010	.0068	.0068	.0000	.06	.0120	.0000	.08	5.3
20673	Sept. 28	V. slight.	V. slight.	.12	7.90	1.50	.0016	.0136	.0130	.0006	.10	.0050	.0000	.14	6.4
21704	Dec. 29	None.	V. slight.	.05	5.90	1.05	.0006	.0056	.0052	.0004	.21	.0200	.0000	.07	4.7
Av...	....	....	....	.11	6.27	1.19	.0011	.0093	.0083	.0010	.11	.0112	.0000	.14	4.8

Odor, faintly vegetable or none. —— The samples were collected from the reservoir.

PITTSFIELD.

Chemical Examination of Water from Sacket Brook in the Vicinity of the Pumping Station of the Pittsfield Water Works.

[Parts per 100,000.]

Number.	Date of Collection.	Appearance.			Residue on Evaporation.		Ammonia.				Chlorine.	Nitrogen as		Oxygen Consumed.	Hardness.
		Turbidity.	Sediment.	Color.	Total.	Loss on Ignition.	Free.	Albuminoid. Total.	Albuminoid. Dissolved.	Albuminoid. Suspended.		Nitrates.	Nitrites.		
18857	1897. Mar. 23	V. slight.	Slight.	.10	6.05	1.30	.0022	.0116	.0098	.0018	.07	.0100	.0000	.18	4.6
19549	June 22	None.	V. slight.	.02	9.60	1.50	.0004	.0060	.0036	.0024	.06	.0100	.0000	.07	7.9
20675	Sept. 28	V. slight.	V. slight.	.05	13.00	2.45	.0026	.0030	.0030	.0000	.08	.0020	.0000	.06	9.9
21703	Dec. 29	V. slight.	Cons.	.05	7.70	1.35	.0004	.0042	.0030	.0012	.12	.0290	.0000	.06	6.1
Av...	....	....	....	.05	9.09	1.65	.0014	.0062	.0048	.0014	.08	.0127	.0000	.09	7.1

Odor, faintly vegetable.—— The samples were collected from the brook.

Chemical Examination of Water from Ashley Brook Reservoir, Pittsfield.

[Parts per 100,000.]

Number.	Date of Collection.	Appearance.			Residue on Evaporation.		Ammonia.				Chlorine.	Nitrogen as		Oxygen Consumed.	Hardness.
		Turbidity.	Sediment.	Color.	Total.	Loss on Ignition.	Free.	Albuminoid. Total.	Albuminoid. Dissolved.	Albuminoid. Suspended.		Nitrates.	Nitrites.		
18859	1897. Mar. 23	V. slight.	Slight.	.30	4.15	0.95	.0006	.0116	.0104	.0012	.06	.0070	.0000	.30	2.6
19545	June 22	None.	None.	.12	7.15	1.70	.0012	.0110	.0104	.0006	.06	.0020	.0000	.26	5.3
20671	Sept. 28	V. slight.	V. slight.	.32	5.40	1.60	.0012	.0104	.0104	.0000	.09	.0000	.0000	.35	3.9
21702	Dec. 29	V. slight.	Cons.	.12	6.10	1.25	.0004	.0084	.0066	.0018	.14	.0190	.0000	.18	4.7
Av...	....	....	....	.21	5.70	1.37	.0008	.0103	.0094	.0009	.09	.0070	.0000	.27	4.1

Odor, faintly vegetable.——The samples were collected from the reservoir. Water flows into this reservoir from Ashley Lake, situated about 2.5 miles farther up the brook.

PITTSFIELD.

Chemical Examination of Water from Hathaway Brook Reservoir, Pittsfield.

[Parts per 100,000.]

Number.	Date of Collection.	Appearance.			Residue on Evaporation.		Ammonia.				Chlorine.	Nitrogen as		Oxygen Consumed.	Hardness.
		Turbidity.	Sediment.	Color.	Total.	Loss on Ignition.	Free.	Albuminoid.				Nitrates.	Nitrites.		
								Total.	Dissolved.	Suspended.					
	1897.														
18856	Mar. 23	V. slight.	Slight.	.07	5.65	1.10	.0000	.0058	.0058	.0000	.07	.0070	.0000	.18	4.0
19546	June 22	None.	V. slight.	.01	9.10	1.65	.0002	.0026	.0024	.0002	.07	.0120	.0000	.05	7.1
20674	Sept. 28	V. slight.	V. slight.	.02	10.30	1.95	.0004	.0044	.0028	.0016	.11	.0075	.0000	.06	8.4
21705	Dec. 29	None.	V. slight.	.03	8.10	1.60	.0002	.0132	.0108	.0024	.14	.0380	.0000	.07	6.4
Av...	....	....	....	.03	8.29	1.57	.0002	.0065	.0054	.0011	.10	.0161	.0000	.09	6.5

Odor, faintly vegetable or none.—The samples were collected from the reservoir.

Chemical Examination of Water from Mill Brook Reservoir, Pittsfield.

[Parts per 100,000.]

Number.	Date of Collection.	Appearance.			Residue on Evaporation.		Ammonia.				Chlorine.	Nitrogen as		Oxygen Consumed.	Hardness.
		Turbidity.	Sediment.	Color.	Total.	Loss on Ignition.	Free.	Albuminoid.				Nitrates.	Nitrites.		
								Total.	Dissolved.	Suspended.					
	1897.														
18855	Mar. 23	Distinct, clayey.	Slight.	.28	4.25	0.90	.0008	.0110	.0104	.0006	.06	.0070	.0000	.23	2.2
19547	June 22	None.	V. slight.	.02	5.30	0.95	.0008	.0046	.0040	.0006	.06	.0050	.0000	.06	3.8
20672	Sept. 28	V. slight.	V. slight.	.03	6.10	1.00	.0016	.0034	.0034	.0000	.09	.0080	.0000	.06	4.9
21706	Dec. 29	V. slight.	Slight.	.03	4.65	0.95	.0006	.0070	.0064	.0006	.13	.0170	.0000	.04	3.6
Av...	....	....	....	.09	5.07	0.95	.0009	.0065	.0060	.0005	.08	.0092	.0000	.10	3.6

Odor, vegetable or none.—The samples were collected from the reservoir.

PLYMOUTH.

Water Supply of Plymouth.

Chemical Examination of Water from Little South Pond, Plymouth.

[Parts per 100,000.]

Number.	Date of Collection.	Appearance.			Residue on Evaporation.		Ammonia.				Chlorine.	Nitrogen as		Oxygen Consumed.	Hardness.
		Turbidity.	Sediment.	Color.	Total.	Loss on Ignition.	Free.	Albuminoid. Total.	Albuminoid. Dissolved.	Albuminoid. Suspended.		Nitrates.	Nitrites.		
	1897.														
18304	Jan. 20	V. slight.	V. slight.	.02	2.75	0.90	.0010	.0136	.0130	.0006	.63	.0000	.0000	.10	0.0
18487	Feb. 10	V. slight.	V. slight.	.02	2.05	0.60	.0018	.0152	.0136	.0016	.70	.0030	.0000	.04	0.0
18717	Mar. 8	V. slight.	V. slight.	.02	2.15	0.60	.0020	.0142	.0120	.0022	.70	.0000	.0000	.07	0.2
19167	May 4	V. slight.	V. slight.	.00	2.25	0.60	.0026	.0146	.0140	.0006	.60	.0030	.0000	.08	0.0
19405	June 8	None.	V. slight.	.05	2.20	0.80	.0012	.0142	.0142	.0000	.62	.0000	.0000	.09	0.2
19708	July 1	V. slight.	V. slight.	.02	2.45	0.65	.0016	.0180	.0160	.0020	.69	.0000	.0000	.12	0.0
19771	July 13	None.	Slight.	.02	2.65	0.80	.0010	.0158	.0128	.0030	.69	.0010	.0000	.08	0.2
20040	Aug. 10	V. slight.	V. slight.	.04	2.40	0.80	.0014	.0146	.0130	.0016	.68	.0020	.0000	.13	0.2
20488	Sept. 15	V. slight.	V. slight.	.03	2.45	0.95	.0004	.0190	.0148	.0042	.66	.0000	.0000	.15	0.0
20761	Oct. 12	V slight.	V. slight.	.03	2.70	1.05	.0014	.0152	.0152	.0000	.69	.0000	.0000	.10	0.0
21063	Nov. 8	V. slight.	Decided.	.05	2.70	1.00	.0012	.0214	.0164	.0050	.66	.0020	.0000	.14	0.5
21519	Dec. 14	V. slight.	Slight.	.07	2.45	0.75	.0016	.0160	.0154	.0006	.70	.0100	.0000	.08	0.3
Av.*.	....	....	....	.03	2.42	0.80	.0014	.0159	.0142	.0017	.67	.0019	.0000	.10	0.1

* Where more than one sample was collected in a month, the mean analysis for that month has been used in making the average.

Odor, vegetable and occasionally mouldy. —— The samples were collected from the pond.

Chemical Examination of Water from Little South Pond, Plymouth, collected near the Bottom.

[Parts per 100,000.]

Number.	Date of Collection.	Appearance.			Residue on Evaporation.		Ammonia.				Chlorine.	Nitrogen as		Oxygen Consumed.	Hardness.
		Turbidity.	Sediment.	Color.	Total.	Loss on Ignition.	Free.	Albuminoid. Total.	Albuminoid. Dissolved.	Albuminoid. Suspended.		Nitrates.	Nitrites.		
	1897.														
19709	July 1	V. slight.	Cons.	.00	2.40	0.65	.0012	.0274	.0124	.0050	.70	.0000	.0000	.08	0.0

Odor, distinctly vegetable.

Microscopical Examination.

Diatomaceæ, *Cymbella*, 2; *Fragilaria*, 30; *Melosira*, 18; *Meridion*, 2; *Nitzschia*, 1; *Pinnularia*, 4; *Stauroneis*, 2; *Synedra*, 10. Miscellaneous, *Zoöglœa*, 60. Total, 129.

PLYMOUTH.

Chemical Examination of Water from Great South, Boot and Halfway Ponds, Plymouth.

[Parts per 100,000.]

Number.	Date of Collection.	Appearance. Turbidity.	Sediment.	Color.	Residue on Evaporation. Total.	Loss on Ignition.	Ammonia. Free.	Albuminoid. Total.	Dissolved.	Sus-pended.	Chlorine.	Nitrogen as Nitrates.	Nitrites.	Oxygen Consumed.	Hardness.
	1897.														
19710	July 1	V. slight.	V. slight.	.00	1.95	0.30	.0002	.0114	.0094	.0020	.66	.0000	.0000	.07	0.0
19711	July 1	V. slight.	V. slight.	.01	2.30	0.50	.0016	.0148	.0102	.0046	.69	.0000	.0000	.08	0.0
19706	July 1	Slight.	V. slight.	.00	3.05	0.90	.0008	.0164	.0150	.0014	.66	.0000	.0000	.19	0.0
19707	July 1	V. slight.	Slight.	.01	3.05	0.95	.0018	.0192	.0158	.0034	.66	.0000	.0000	.20	0.0
19705	July 1	Slight.	Slight.	.05	2.65	0.50	.0004	.0234	.0122	.0112	.62	.0030	.0000	.11	0.0
21513	Dec. 13	V. slight.	V. slight.	.09	2.50	1.10	.0018	.0240	.0166	.0074	.62	.0080	.0000	.14	0.5

Odor, distinctly vegetable.—— The samples were collected as follows: No. 19710, from Great South Pond, near the surface; No. 19711, from Great South Pond, near the bottom; No. 19706, from Boot Pond, near the surface; No. 19707, from Boot Pond, near the bottom; No. 19705, from Halfway Pond, near the surface; No. 21513, from Halfway Pond, at its outlet.

Microscopical Examination.

The organisms *Anabæna* and *Dinobryon* were found in Nos. 19706, 19707 and 21513.

Water Supply of Provincetown.

Chemical Examination of Water from the Tubular Wells of the Provincetown Water Works.

[Parts per 100,000.]

Number.	Date of Collection.	Appearance. Turbidity.	Sediment.	Color.	Residue on Evaporation.	Ammonia. Free.	Albuminoid.	Chlorine.	Nitrogen as Nitrates.	Nitrites.	Oxygen Consumed.	Hardness.	Iron.
	1897.												
18259	Jan. 16	Decided, milky.	Cons., rusty.	1.30	10.00	.0114	.0110	2.00	.0120	.0001	.58	3.5	.5800
18394	Jan. 29	Distinct, milky.	Cons., rusty.	1.30	9.40	.0090	.0098	2.22	.0030	.0000	.65	2.6	.3600
18719	Mar. 8	Distinct, milky.	Slight.	1.50	7.90	.0120	.0104	2.33	.0030	.0000	.70	2.5	.3300
18828	Mar. 22	Decided.	Cons., floc.	1.25	8.20	.0126	.0120	2.35	.0080	.0000	.67	2.2	.6700
18979	Apr. 7	Decided.	Cons., floc.	1.40	8.90	.0128	.0104	2.21	.0070	.0000	.77	3.1	.3200
19173	May 4	Decided.	Cons., floc.	1.70	9.40	.0130	.0120	2.37	.0030	.0001	.72	2.1	.6200
19387	June 4	Distinct.	Cons., rusty.	1.80	9.40	.0104	.0132	2.20	.0030	.0000	.70	2.9	.6800
19741	July 7	Decided.	Cons.	2.00	9.30	.0122	.0098	2.21	.0050	.0000	.89	3.3	.3900
20006	Aug. 4	Decided.	Cons., rusty.	1.20	10.20	.0126	.0106	2.51	.0080	.0000	.62	3.6	.8500
20418	Sept. 8	Distinct, milky.	Cons., rusty.	1.90	10.00	.0066	.0110	2.39	.0030	.0000	.75	3.4	.9000
20723	Oct. 5	Distinct, milky.	Cons., rusty.	2.30	10.10	.0128	.0096	2.39	.0000	.0000	.74	3.8	.9000
21041	Nov. 3	Decided.	Cons.	1.85	10.00	.0134	.0170	2.29	.0000	.0000	.82	4.7	.6000
21475	Dec. 7	Cons.	Cons.	2.40	9.40	.0124	.0128	2.26	.0050	.0002	.73	5.0	.6000

PROVINCETOWN.

Chemical Examination of Water from the Tubular Wells of the Provincetown Water Works — Concluded.

Averages by Years.

[Parts per 100,000.]

Number.	Date of Collection.	Appearance.			Residue on Evaporation.	Ammonia.		Chlorine.	Nitrogen as		Oxygen Consumed.	Hardness.	Iron.
		Turbidity.	Sediment.	Color.		Free.	Albuminoid.		Nitrates.	Nitrites.			
-	1893	-	-	0.99	7.65	.0027	.0082	2.08	.0023	.0001	.74	1.4	.1340
-	1894	-	-	1.09	7.91	.0043	.0090	2.19	.0039	.0000	.69	1.7	.2212
-	1895	-	-	1.21	8.56	.0074	.0106	2.18	.0043	.0000	.77	2.2	.3764
-	1896	-	-	1.34	9.12	.0080	.0125	2.28	.0058	.0000	.75	2.0	.5162
-	1897*	-	-	1.71	9.51	.0116	.0115	2.28	.0045	.0000	.72	3.4	.6083

* Where more than one sample was collected in a month, the mean analysis for that month has been used in making the average.

NOTE to analyses of 1897: Odor, none. A faintly mouldy or earthy odor was developed in some of the samples on heating. —— The samples were collected from a faucet at the pumping station.

Microscopical Examination of Water from the Tubular Wells of the Provincetown Water Works.

[Number of organisms per cubic centimeter.]

	1897.												
	Jan.	Feb.	Mar.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
Day of examination,	16	1	9	24	9	7	10	9	6	10	7	5	9
Number of sample,	18259	18394	18719	18828	18979	19173	19387	19741	20006	20418	20723	21041	21475
PLANTS.													
Fungi, Crenothrix,	268	18,000	1,000	600	300	72	60	0	16	24	100	0	0

Chemical Examination of Water from Faucets in Provincetown, supplied from the Provincetown Water Works.

[Parts per 100,000.]

Number.	Date of Collection.	Appearance.			Residue on Evaporation.	Ammonia.		Chlorine.	Nitrogen as		Oxygen Consumed.	Hardness.	Iron.
		Turbidity.	Sediment.	Color.		Free.	Albuminoid.		Nitrates.	Nitrites.			
	1897.												
18665	Feb. 27	Slight, milky.	Cons., rusty.	1.00	13.80	.0058	.0100	2.26	.0000	.0000	.73	3.0	.8900
18666	Feb. 27	Distinct, milky.	Cons.	1.20	8.60	.0054	.0134	2.31	.0030	.0000	.73	1.7	.4600
19742	July 7	Decided.	Slight.	1.40	8.90	.0036	.0118	2.33	.0020	.0000	.87	2.9	.2800
20007	Aug. 4	Decided, milky.	Cons.	-	10.00	.0018	.0108	2.52	.0000	.0000	.60	3.0	.4800
20419	Sept. 8	Distinct, milky.	Slight, rusty.	1.60	10.20	.0058	.0106	2.38	.0010	.0001	.64	3.8	.4400
20724	Oct. 6	Distinct, milky.	Slight.	1.80	9.20	.0028	.0116	2.45	.0000	.0000	.57	3.3	.4500
21042	Nov. 3	Decided.	Cons.	1.70	9.80	.0042	.0158	2.24	.0000	.0000	.59	4.0	.4000
21476	Dec. 7	Great.	Cons.	0.70	9.30	.0014	.0120	2.30	.0020	.0003	.33	4.4	.2600
Av.*.	....	....	....	1.34	9.80	.0036	.0120	2.36	.0009	.0001	.62	3.4	.4264

* Where more than one sample was collected in a month, the mean analysis for that month has been used in making the average.

Odor of the first two samples, faintly mouldy; of the others, none, becoming generally faintly mouldy or earthy on heating. —— The samples were collected from faucets in the town.

Water Supply of Quincy.

The advice of the State Board of Health to the city of Quincy, with reference to a proposed temporary additional water supply, to be taken from Town Brook near the pumping station during the drier months of the year, may be found on pages 36 and 37 of this volume. The results of analyses of samples of water from this brook and its tributaries are given in the following table : —

Chemical Examination of Water from Town Brook, just above the Storage Reservoir of the Quincy Water Works.

[Parts per 100,000.]

Number.	Date of Collection.	Appearance.			Residue on Evaporation.		Ammonia.				Chlorine.	Nitrogen as		Oxygen Consumed.	Hardness.
		Turbidity.	Sediment.	Color.	Total.	Loss on Ignition.	Free.	Albuminoid. Total.	Albuminoid. Dissolved.	Albuminoid. Suspended.		Nitrates.	Nitrites.		
	1897.														
18342	Jan. 25	V. slight.	Slight.	0.35	4.60	1.75	.0008	.0254	.0136	.0118	.67	.0170	.0001	0.32	1.1
18607	Feb. 23	Distinct.	Cons.	0.50	3.65	1.35	.0044	.0180	.0158	.0022	.45	.0050	.0000	0.54	0.8
18871	Mar. 24	Slight.	Cons.	0.60	3.40	1.70	.0008	.0176	.0146	.0030	.50	.0050	.0000	0.50	0.5
19105	Apr. 26	V. slight.	Slight.	0.95	3.65	1.50	.0004	.0226	.0216	.0010	.60	.0030	.0000	0.70	0.6
19298	May 24	Slight.	Cons.	1.50	4.25	2.15	.0006	.0244	.0224	.0020	.54	.0030	.0000	1.11	0.6
19586	June 28	None.	V. slight.	1.65	5.55	2.65	.0016	.0332	.0308	.0024	.43	.0100	.0001	1.26	1.1
19906	July 26	V. slight.	Slight.	1.25	5.70	2.35	.0008	.0300	.0256	.0044	.70	.0100	.0000	1.08	1.0
20321	Aug. 30	Slight.	Slight.	1.12	5.95	2.75	.0068	.0834	.0736	.0098	.63	.0050	.0000	1.07	0.9
20639	Sept. 27	Slight.	Cons.	0.60	1.55	0.30	.0012	.0190	.0166	.0024	.68	.0050	.0001	0.51	0.9
20949	Oct. 25	V. slight.	V. slight.	0.88	4.80	1.75	.0000	.0154	.0154	.0000	.66	.0130	.0000	0.43	1.1
21395	Nov. 29	V. slight.	Slight.	1.00	5.25	2.15	.0008	.0162	.0140	.0022	.64	.0030	.0000	0.82	0.8
21690	Dec. 29	V. slight.	Slight.	0.40	4.85	1.65	.0006	.0084	.0076	.0008	.78	.0170	.0000	0.40	1.7

Averages by Years.

-	1889	-	-	1.21	4.61	1.87	.0013	.0239	.0203	.0036	.48	.0073	.0001	-	-
	1890	-	-	0.73	5.22	2.17	.0024	.0187	.0155	.0032	.52	.0125	.0002	-	1.3
-	1891	-	-	0.72	4.22	1.50	.0004	.0156	.0132	.0024	.49	.0112	.0001	-	0.7
-	1892	-	-	0.87	4.57	1.56	.0041	.0191	.0159	.0032	.55	.0114	.0001	-	0.8
-	1893	-	-	0.93	4.53	1.81	.0014	.0168	.0140	.0028	.57	.0110	.0001	0.79	0.8
-	1894	-	-	0.92	4.31	1.62	.0003	.0158	.0134	.0024	.63	.0030	.0000	0.64	0.6
-	1895	-	-	0.84	4.31	1.73	.0002	.0177	.0152	.0025	.59	.0061	.0001	0.64	0.6
-	1896	-	-	0.81	4.27	1.64	.0004	.0185	.0169	.0016	.57	.0061	.0000	0.73	0.7
-	1897	-	-	0.90	4.43	1.84	.0016	.0261	.0226	.0035	.61	.0080	.0000	0.73	0.9

Note to analyses of 1897: Odor, distinctly vegetable. —— The samples were collected from the brook, above the reservoir.

QUINCY.

Chemical Examination of Water from the Storage Reservoir of the Quincy Water Works.

[Parts per 100,000.]

Number.	Date of Collection.	Appearance.			Residue on Evaporation.		Ammonia.				Chlorine.	Nitrogen as		Oxygen Consumed.	Hardness.
								Albuminoid.							
		Turbidity.	Sediment.	Color.	Total.	Loss on Ignition	Free.	Total.	Dissolved.	Sus-pended.		Nitrates.	Nitrites.		
	1897.														
18343	Jan. 25	Slight.	V. slight.	0.33	3.60	1.70	.0016	.0206	.0186	.0020	.58	.0100	.0001	.33	1.1
18608	Feb. 23	V. slight.	V. slight.	0.42	4.15	1.35	.0012	.0146	.0122	.0024	.65	.0100	.0000	.41	0.5
18661	Feb. 25	V. slight.	V. slight.	0.45	3.65	1.15	.0014	.0146	.0134	.0012	.66	.0130	.0000	.45	0.5
18872	Mar. 24	Slight.	V. slight.	0.43	3.90	1.60	.0004	.0168	.0120	.0048	.59	.0180	.0000	.34	0.5
19106	Apr. 26	Slight.	Slight.	0.33	3.05	1.00	.0024	.0214	.0156	.0058	.61	.0070	.0001	.36	0.3
19299	May 24	Distinct.	Cons.	0.52	3.40	1.15	.0008	.0230	.0162	.0068	.58	.0030	.0000	.55	0.5
19587	June 28	V. slight.	Slight.	0.66	3.50	1.50	.0008	.0270	.0216	.0054	.59	.0000	.0000	.61	0.5
19907	July 26	Slight.	Slight.	0.86	4.05	1.50	.0018	.0298	.0210	.0088	.65	.0070	.0000	.60	0.8
20322	Aug. 30	Slight.	Slight.	0.69	3.95	1.65	.0016	.0344	.0256	.0088	.63	.0000	.0000	.63	1.0
20638	Sept. 27	Slight.	Slight.	1.00	4.35	1.90	.0100	.0342	.0296	.0046	.65	.0000	.0000	.52	1.1
20950	Oct. 25	Distinct.	Cons.	0.95	4.05	1.75	.0144	.0330	.0286	.0044	.68	.0200	.0000	.41	0.8
21396	Nov. 29	Distinct.	Cons.	0.70	4.80	1.90	.0076	.0218	.0184	.0034	.72	.0120	.0000	.52	0.5
21691	Dec. 29	Decided.	Slight.	0.60	4.50	1.80	.0038	.0184	.0152	.0032	.74	.0130	.0000	.48	1.3

Averages by Years.

-	1889	-	-	0.91	3.76	1.19	.0116	.0303	.0238	.0065	.53	.0087	.0003	-	-
-	1890	-	-	0.70	4.56	1.76	.0085	.0249	.0178	.0071	.54	.0166	.0002	-	1.4
-	1891	-	-	0.70	3.97	1.60	.0027	.0274	.0178	.0096	.50	.0100	.0000	-	0.7
-	1892	-	-	0.62	4.07	1.41	.0051	.0237	.0175	.0062	.61	.0098	.0001	-	0.9
-	1893	-	-	0.56	3.81	1.51	.0052	.0218	.0172	.0046	.61	.0104	.0001	.51	0.8
-	1894	-	-	0.67	4.26	1.71	.0020	.0229	.0167	.0062	.67	.0053	.0000	.60	0.8
-	1895	-	-	0.66	4.22	1.77	.0008	.0301	.0187	.0114	.65	.0040	.0000	.56	0.7
-	1896	-	-	0.57	3.86	1.47	.0021	.0238	.0168	.0070	.63	.0062	.0001	.49	0.7
-	1897*	-	-	0.62	3.92	1.56	.0039	.0246	.0196	.0050	.64	.0085	.0000	.48	0.7

* Where more than one sample was collected in a month, the mean analysis for that month has been used in making the average.

NOTE to analyses of 1897: Odor, distinctly vegetable; in January and July becoming fishy on heating. —— The samples were collected from the reservoir. For monthly record of height of water in this reservoir, see page 282.

QUINCY.

Microscopical Examination of Water from the Storage Reservoir of the Quincy Water Works.

[Number of organisms per cubic centimeter.]

	1897.												
	Jan.	Feb.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Oct.	Oct.	Nov.	Dec.
Day of examination,	27	24	26	27	27	25	30	27	31	2	26	30	30
Number of sample,	18343	18608	18661	18872	19106	19299	19587	19907	20322	20638	20950	21396	21691
PLANTS.													
Diatomaceæ,	2	8	1	1	42	64	42	54	926	316	596	908	684
Asterionella,	0	8	1	0	8	10	0	0	836	68	344	840	476
Synedra,	2	0	0	0	7	16	0	4	8	12	28	10	112
Tabellaria,	0	0	0	1	27	34	36	50	82	232	204	54	96
Cyanophyceæ, Clathrocystis,	0	0	0	0	0	0	0	0	32	0	0	0	0
Algæ,	0	2	0	0	0	3	2	2	31	88	72	40	4
Protococcus,	0	2	0	0	0	0	0	0	27	66	48	0	0
ANIMALS.													
Rhizopoda,	0	0	1	0	0	0	2	0	0	0	0	0	0
Infusoria,	430	44	68	145	59	427	64	70	50	26	32	16	252
Codonella,	0	0	0	0	0	4	0	0	0	0	12	4	2
Dinobryon,	16	6	6	10	14	376	0	2	38	4	0	0	4
Mallomonas,	2	10	2	11	0	6	4	0	0	0	0	4	0
Peridinium,	408	22	60	124	40	36	32	60	8	2	4	2	244
Raphidomonas,	0	0	0	0	0	0	28	2	0	0	0	0	0
Uroglena,	0	0	0	0	3	0	0	0	0	0	0	0	0
Vermes,	0	0	0	1	4	2	1	0	4	0	8	2	8
Crustacea, Cyclops,	0	0	0	0	0	0	0	pr.	0	pr.	pr.	pr.	0
Miscellaneous, Zoöglœa,	0	10	0	0	20	0	60	0	25	200	25	15	0
TOTAL,	432	64	70	147	125	496	171	126	1,068	630	733	981	948

QUINCY.

Chemical Examination of Water from Town Brook and its Tributaries.

[Parts per 100,000.]

Number.	Date of Collection.	Appearance.			Residue on Evaporation.		Ammonia.				Chlorine.	Nitrogen as		Oxygen Consumed.	Hardness.
								Albuminoid.							
		Turbidity.	Sediment.	Color.	Total.	Loss on Ignition.	Free.	Total.	Dissolved.	Sus-pended.		Nitrates.	Nitrites.		
	1897.														
18658	Feb. 25	Slight.	Slight.	.35	8.55	2.80	.0314	.0200	.0174	.0026	1.53	.1080	.0011	.42	2.6
18659	Feb. 25	V. slight.	Slight.	.75	3.45	1.35	.0002	.0110	.0098	.0012	0.49	.0030	.0000	.54	0.3
18660	Feb. 25	V. slight.	Slight.	.68	4.90	1.60	.0094	.0196	.0194	.0002	0.79	.0180	.0002	.54	0.9

Odor, distinctly vegetable. —— The first sample was collected from a small tributary of Town Brook, which enters it from the south about half a mile below the reservoir of the Quincy water works; the second sample was collected from a brook north of the storage reservoir, which unites with Town Brook a short distance below the reservoir; the last sample was collected from Town Brook, opposite the pumping station of the Quincy water works.

Table showing Heights of Water in the Storage Reservoir of the Quincy Water Works on the First of Each Month in 1897.

[High-water mark is 86.71 feet above city base.]

1897.	Heights above City Base.	1897.	Heights above City Base.
	Feet.		Feet.
Jan. 1, ...	86.71	July 1, ...	85.80
Feb. 1, ...	86.71	Aug. 1, ...	83.98
March 1, ...	86.71	Sept. 1, ...	82.60
April 1, ...	86.71	Oct. 1, ...	80.01
May 1, ...	86.71	Nov. 1, ...	76.81
June 1, ...	86.60	Dec. 1, ...	79.11

Water Supply of Randolph and Holbrook.

Chemical Examination of Water from Great Pond in Randolph and Braintree.

[Parts per 100,000.]

Number.	Date of Collection.	Appearance.			Residue on Evaporation.		Ammonia.				Chlorine.	Nitrogen as		Oxygen Consumed.	Hardness.
								Albuminoid.							
		Turbidity.	Sediment.	Color.	Total.	Loss on Ignition.	Free.	Total.	Dissolved.	Sus-pended.		Nitrates.	Nitrites.		
	1897.														
18961	Apr. 6	V. slight.	V. slight.	.48	3.70	1.25	.0002	.0118	.0108	.0010	.56	.0150	.0000	.43	1.3
19596	June 29	None.	V. slight.	.59	4.10	1.55	.0002	.0188	.0146	.0042	.50	.0070	.0000	.62	0.9
20368	Sept. 3	V. slight.	V. slight.	.43	3.95	1.85	.0000	.0232	.0208	.0024	.57	.0000	.0000	.60	1.0
20745	Oct. 11	V. slight.	V. slight.	.40	4.05	1.70	.0004	.0208	.0188	.0020	.58	.0030	.0000	.46	0.8
21472	Dec. 8	V. slight.	V. slight.	.48	4.25	1.75	.0010	.0206	.0186	.0020	.68	.0070	.0002	.54	1.3
Av. . .	. . . .	. . . .	. . . .	.48	4.01	1.62	.0004	.0190	.0167	.0023	.58	.0064	.0000	.53	1.1

Odor, generally faintly vegetable. —— The samples were collected from a faucet in Holbrook.

Water Supply of Reading.

Chemical Examination of Water from the Filter-gallery of the Reading Water Works.

[Parts per 100,000.]

Number.	Date of Collection.	Appearance.			Residue on Evaporation.	Ammonia.		Chlorine.	Nitrogen as		Oxygen Consumed.	Hardness.	Iron.
		Turbidity.	Sediment.	Color.		Free.	Albuminoid.		Nitrates.	Nitrites.			
	1897.												
18242	Jan. 12	Decided, milky.	Cons.	0.70	15.80	.0088	.0072	.56	.0050	.0002	.23	4.9	.5000
18358	Jan. 26	Distinct, milky.	Slight, rusty.	0.70	13.20	.0096	.0132	.52	.0080	.0001	.37	3.8	.3700
18460	Feb. 9	Distinct, milky.	Cons., rusty.	0.40	13.50	.0088	.0080	.52	.0150	.0000	.25	5.7	.2400
18609	Feb. 23	Distinct, milky.	Heavy.	1.00	16.20	.0106	.0096	.53	.0070	.0001	.47	5.9	.7600
18709	Mar. 8	Distinct, milky.	Slight.	0.75	12.10	.0084	.0090	.56	.0050	.0000	.35	3.5	.2200
18819	Mar. 22	Distinct, milky.	Cons., rusty.	0.70	11.10	.0082	.0064	.50	.0070	.0001	.30	4.9	.2900
18958	Apr. 5	Decided.	Cons., floc.	0.60	10.70	.0060	.0050	.46	.0050	.0000	.32	4.4	.1400
19071	Apr. 20	V. slight, milky.	Slight.	0.63	10.00	.0084	.0086	.47	.0030	.0000	.40	4.3	.2100
19195	May 10	Distinct, milky.	Cons., rusty.	0.80	9.40	.0058	.0078	.46	.0150	.0001	.39	3.9	.1600
19303	May 24	Distinct, milky.	Cons., rusty.	1.20	9.80	.0082	.0110	.41	.0030	.0001	.63	3.5	.1200
19394	June 7	Distinct.	Cons., floc.	1.30	10.10	.0096	.0142	.36	.0050	.0000	.68	3.5	.3000
19527	June 21	Decided.	Cons.	1.15	11.30	.0082	.0154	.40	.0050	.0001	.40	4.2	.2200
19765	July 12	Distinct, milky.	Cons.	1.45	9.40	.0092	.0172	.41	.0030	.0000	.99	2.5	.1750
19908	July 26	Distinct.	Cons.	1.20	9.00	.0086	.0158	.73	.0130	.0000	.45	3.0	.2950
20034	Aug. 9	Decided.	Cons.	–	10.80	.0104	.0134	.52	.0020	.0000	.37	3.8	.2300
20282	Aug. 25	Distinct.	Cons.	0.50	12.20	.0084	.0126	.61	.0030	.0000	.82	4.3	.3300
20467	Sept. 13	Distinct, milky.	Cons., rusty.	1.20	9.50	.0082	.0152	.73	.0020	.0000	.79	3.2	.2900
20648	Sept. 27	Distinct, milky.	Slight.	0.42	8.60	.0088	.0128	.50	.0000	.0001	.25	2.7	.4500
20747	Oct. 11	Distinct, milky.	Cons.	0.53	9.60	.0072	.0098	.51	.0030	.0000	.45	3.4	.1250
20953	Oct. 25	Distinct, milky.	Cons.	0.50	10.00	.0078	.0082	.77	.0100	.0000	.31	3.8	.1350
21098	Nov. 9	Decided.	Cons.	0.61	10.10	.0106	.0110	.55	.0030	.0001	.36	4.4	.1750
21319	Nov. 22	Decided.	Heavy.	0.60	9.60	.0130	.0126	.55	.0060	.0003	.32	3.9	.1950
21515	Dec. 13	Decided.	Heavy.	0.40	11.40	.0118	.0108	.53	.0050	.0003	.36	4.2	.2000
21693	Dec. 29	Decided.	Heavy.	0.50	13.40	.0106	.0098	.50	.0070	.0002	.40	4.6	.2160

Averages by Years.

–	1891	–	–	0.13	12.96	.0016	.0063	.43	.0094	.0001	–	5.1	–
–	1892	–	–	0.44	9.25	.0042	.0073	.54	.0071	.0001	–	3.4	–
–	1893	–	–	0.64	10.08	.0034	.0087	.56	.0032	.0001	.35	3.9	.1251
–	1894	–	–	0.45	12.76	.0043	.0107	.68	.0029	.0000	.35	5.0	.2642
–	1895	–	–	0.61	13.88	.0088	.0114	.72	.0048	.0000	.44	5.5	.2277
–	1896	–	–	0.52	11.50	.0080	.0089	.51	.0059	.0001	.40	4.1	.2696
–	1897*	–	–	0.76	11.12	.0090	.0110	.53	.0058	.0001	.44	4.0	.2644

* Where more than one sample was collected in a month, the mean analysis for that month has been used in making the average.

NOTE to analyses of 1897: Odor of Nos. 18609, 18819, 18958 and 19071, faintly mouldy; of No. 21319, distinctly unpleasant; of the others, none. A faintly mouldy or earthy odor was developed in some of the samples on heating. —— The samples were collected from a faucet at the pumping station.

READING.

Microscopical Examination of Water from the Filter-gallery of the Reading Water Works.

[Number of organisms per cubic centimeter.]

	1897.											
	Jan.	Jan.	Feb.	Feb.	Mar.	Mar.	Apr.	Apr.	May.	May.	June.	June.
Day of examination, .	13	29	10	24	9	23	7	21	11	25	10	22
Number of sample, .	18242	18358	18460	18609	18709	18819	18958	19071	19195	19303	19394	19527
PLANTS.												
Fungi, Crenothrix, .	19,200	16,000	19,000	6,000	6,800	8,200	15,500	1,000	4,400	9,300	24,000	7,200

Microscopical Examination of Water from the Filter-gallery of the Reading Water Works — Concluded.

[Number of organisms per cubic centimeter.]

	1897.											
	July.	July.	Aug.	Aug.	Sept.	Oct.	Oct.	Oct.	Nov.	Nov.	Dec.	Dec.
Day of examination, .	16	28	11	27	15	4	12	26	12	24	15	30
Number of sample, .	19765	19908	20034	20282	20467	20648	20747	20953	21098	21319	21515	21693
PLANTS.												
Fungi, Crenothrix, .	4,200	4,500	7,000	10,000	8,000	4,736	4,000	5,000	10,000	5,000	12,000	600

READING.

Chemical Examination of Water from Reading Filter-gallery after passing through the Mechanical Filter.

[Parts per 100,000.]

Number.	Date of Collection.	Appearance.			Residue on Evaporation.	Ammonia.		Chlorine.	Nitrogen as		Oxygen Consumed.	Hardness.	Iron.
		Turbidity.	Sediment.	Color.		Free.	Albuminoid.		Nitrates.	Nitrites.			
	1897.												
18243	Jan. 12	None.	None.	.10	24.10	.0082	.0096	.55	.0050	.0007	.22	15.5	.0100
18359	Jan. 26	None.	None.	.10	23.40	.0060	.0100	.52	.0070	.0005	.18	15.0	.0000
18461	Feb. 9	None.	None.	.07	21.80	.0064	.0092	.51	.0120	.0003	.09	15.0	.0020
18610	Feb. 23	None.	None.	.06	20.80	.0044	.0054	.46	.0050	.0001	.18	15.0	.0000
18710	Mar. 8	None.	None.	.05	26.20	.0062	.0092	.48	.0100	.0006	.22	13.5	.0000
18820	Mar. 22	None.	None.	.07	17.60	.0038	.0066	.50	.0080	.0002	.15	14.5	.0000
18959	Apr. 5	None.	None.	.10	17.60	.0008	.0054	.44	.0050	.0000	.23	11.0	.0020
19072	Apr. 20	None.	None.	.20	17.50	.0014	.0064	.42	.0050	.0000	.28	13.0	.0000
19196	May 10	None.	None.	.25	15.50	.0010	.0068	.44	.0270	.0002	.29	12.5	.0040
19304	May 24	None.	None.	.35	16.50	.0012	.0070	.40	.0130	.0003	.37	10.5	.0000
19395	June 7	None.	None.	.40	17.30	.0004	.0084	.36	.0050	.0001	.37	11.0	.0100
19528	June 21	None.	None.	.48	19.20	.0056	.0110	.44	.0030	.0009	.43	13.5	.0080
19766	July 12	None.	None.	.63	17.60	.0042	.0116	.45	.0030	.0006	.56	13.0	.0240
19909	July 26	V. slight.	None.	.33	17.40	.0010	.0080	.77	.0200	.0004	.44	10.2	.0040
20035	Aug. 9	None.	None.	.37	19.40	.0054	.0080	.52	.0030	.0015	.42	12.1	.0000
20283	Aug. 25	None.	None.	.43	18.50	.0032	.0118	.70	.0050	.0015	.50	11.5	.0040
20468	Sept. 13	None.	None.	.30	18.70	.0024	.0060	.73	.0030	.0013	.32	10.9	.0060
20649	Sept. 27	None.	None.	.15	18.00	.0006	.0064	.49	.0020	.0012	.30	11.5	.0010
20748	Oct. 11	None.	None.	.20	18.10	.0016	.0070	.53	.0100	.0045	.30	11.2	.0020
20954	Oct. 25	None.	None.	.27	17.00	.0020	.0088	.53	.0120	.0030	.21	14.3	.0060
21099	Nov. 9	None.	None.	.21	16.70	.0030	.0112	.68	.0030	.0025	.22	14.5	.0020
21320	Nov. 22	None.	None.	.19	16.80	.0040	.0124	.50	.0160	.0002	.24	13.0	.0010
21516	Dec. 13	None.	None.	.19	17.30	.0036	.0090	.54	.0080	.0024	.22	14.5	.0020
21694	Dec. 29	None.	None.	.14	18.00	.0044	.0076	.53	.0080	.0019	.21	9.3	.0020
Av.*	....	....	....	.23	18.54	.0034	.0084	.52	.0082	.0010	.29	12.7	.0037

* Where more than one sample was collected in a month, the mean analysis for that month has been used in making the average.

Odor, none.—— The samples were collected from the weir, over which the filtered water passes on its entrance to the storage tank at the pumping station.

REVERE.

Water Supply of Revere and Winthrop. — Revere Water Company.

Chemical Examination of Water from the Wells of the Revere Water Company at Revere.

[Parts per 100,000.]

Number.	Date of Collection.	Appearance.			Residue on Evaporation.	Ammonia.		Chlorine.	Nitrogen as		Oxygen Consumed.	Hardness.	Iron.
		Turbidity.	Sediment.	Color.		Free.	Albu-minoid.		Nitrates.	Nitrites.			
	1897.												
18249	Jan. 13	None.	None.	.00	150.60	.0006	.0012	58.97	.1500	.0011	.07	44.5	.0120
18434	Feb. 4	None.	None.	.02	154.10	.0000	.0002	62.36	.1600	.0011	.08	42.0	.0100
18703	Mar. 4	None.	Slight.	.03	159.00	.0006	.0030	62.37	.1250	.0007	.27	47.0	.0150
18956	Apr. 5	None.	None.	.00	154.30	.0004	.0010	63.90	.1400	.0014	.13	62.0	.0050
19279	May 19	None.	None.	.05	152.00	.0002	.0018	61.10	.1650	.0018	.19	46.5	.0100
19683	June 30	None.	None.	.00	159.80	.0000	.0010	67.50	.0750	.0016	.13	51.5	.0070
19756	July 6	None.	V. slight.	.00	169.80	.0000	.0008	75.20	.0900	.0040	.09	52.3	.0090
20009	Aug. 5	None.	V. slight.	.02	154.70	.0004	.0010	57.92	.1100	.0020	.08	45.7	.0050
20551	Sept. 14	None.	None.	.02	169.40	.0008	.0028	62.00	.0650	.0020	.10	46.5	.0000
20763	Oct. 7	None.	None.	.00	125.20	.0006	.0006	45.26	.0570	.0026	.09	38.0	.0040
21234	Nov. 11	V. slight.	Slight.	.03	142.50	.0006	.0030	56.60	.2300	.0028	.10	57.0	.0020
21499	Dec. 7	V. slight.	V. slight.	.06	104.40	.0016	.0064	38.00	.1600	.0022	.09	43.5	.0020

Averages by Years.

-	1888	-	-	.00	22.69	.0001	.0022	3.49	.1288	.0022	-	-	-
-	1893	-	-	.00	50.29	.0002	.0019	13.05	.0907	.0019	.04	23.0	.0036
-	1894	-	-	.03	91.99	.0004	.0011	30.80	.0963	.0013	.06	41.0	.0219
-	1895	-	-	.02	104.73	.0002	.0012	36.84	.0652	.0014	.07	45.5	.0120
-	1896	-	-	.00	121.30	.0002	.0011	45.21	.0733	.0017	.08	46.4	.0032
-	1897	-	-	.02	149.65	.0005	.0019	59.26	.1272	.0019	.12	48.0	.0067

Note to analyses of 1897: Odor, none.——The samples were collected from a faucet at the pumping station.

REVERE.

Chemical Examination of Water from Tubular Wells of the Revere Water Company at Cliftondale, Saugus.

[Parts per 100,000.]

Number.	Date of Collection.	Appearance.			Residue on Evaporation.	Ammonia.		Chlorine.	Nitrogen as		Oxygen Consumed.	Hardness.	Iron.
		Turbidity.	Sediment.	Color.		Free.	Albuminoid.		Nitrates.	Nitrites.			
	1897.												
18250	Jan. 13	None.	None.	.00	15.30	.0000	.0042	1.18	.1900	.0000	.01	6.3	.0070
18435	Feb. 4	None.	None.	.00	13.70	.0012	.0050	1.31	.1760	.0000	.00	6.0	.0050
18704	Mar. 4	None.	None.	.00	13.60	.0000	.0020	1.13	.2000	.0000	.06	6.9	.0040
18957	Apr. 5	None.	None.	.00	13.50	.0000	.0016	1.28	.1500	.0000	.03	7.0	.0000
19280	May 19	None.	None.	.00	13.10	.0000	.0024	1.27	.1900	.0000	.02	7.0	.0000
19684	June 30	None.	None.	.00	14.00	.0002	.0012	1.30	.1000	.0004	.00	6.7	.0000
19757	July 8	None.	None.	.00	14.70	.0000	.0006	1.48	.2000	.0000	.01	7.2	.0030
20010	Aug. 5	None.	None.	.00	14.10	.0002	.0014	1.27	.1300	.0000	.01	7.0	.0000
20552	Sept. 14	None.	None.	.02	13.90	.0002	.0018	1.27	.1500	.0000	.02	6.7	.0000
20764	Oct. 8	None.	None.	.00	13.90	.0006	.0008	1.14	.1040	.0000	.05	7.2	.0000
21233	Nov. 11	None.	None.	.05	14.50	.0026	.0026	1.33	.2000	.0005	.01	7.6	.0010
21498	Dec. 7	V. slight.	None.	.05	14.30	.0014	.0052	1.42	.1900	.0000	.02	7.7	.0010

Averages by Years.

-	1892	-	-	.01	11.65	.0000	.0003	1.16	.0123	.0035	-	6.0	.0116
-	1893	-	-	.00	12.60	.0002	.0010	1.32	.0872	.0079	.03	6.4	.0037
-	1894	-	-	.01	13.08	.0000	.0010	1.24	.0706	.0012	.03	6.5	.0058
-	1895	-	-	.01	13.62	.0003	.0016	1.18	.1058	.0033	.03	6.9	.0011
-	1896	-	-	.01	14.08	.0002	.0012	1.26	.1320	.0002	.02	6.9	.0024
-	1897	-	-	.01	14.05	.0005	.0024	1.28	.1650	.0001	.02	6.9	.0017

NOTE to analyses of 1897: Odor, none. —— The samples were collected from faucets in Revere and Saugus, supplied wholly from the Saugus wells.

WATER SUPPLY OF ROCKLAND.

(See *Abington.*)

ROCKPORT.

Water Supply of Rockport.

Chemical Examination of Water from Cape Pond, Rockport.

[Parts per 100,000.]

Number.	Date of Collection.	Appearance.			Residue on Evaporation.		Ammonia.				Chlorine.	Nitrogen as		Oxygen Consumed.	Hardness.
		Turbidity.	Sediment.	Color.	Total.	Loss on Ignition.	Free.	Albuminoid. Total.	Albuminoid. Dissolved.	Albuminoid. Sus-pended.		Nitrates.	Nitrites.		
	1897.														
18288	Jan. 18	Slight, milky.	V. slight.	.30	13.00	2.25	.0000	.0232	.0194	.0038	4.88	.0000	.0001	.35	1.1
18503	Feb. 15	V. slight.	V. slight.	.20	11.60	2.00	.0022	.0202	.0184	.0018	4.87	.0030	.0000	.27	1.1
18821	Mar. 22	Distinct.	V. slight.	.38	10.70	2.15	.0002	.0258	.0238	.0020	4.60	.0020	.0000	.30	1.3
18997	Apr. 12	Slight.	Slight.	.32	11.10	1.95	.0006	.0308	.0226	.0082	4.49	.0000	.0000	.30	0.8
19261	May 17	V. slight.	V. slight.	.28	10.05	1.10	.0032	.0116	.0112	.0004	4.44	.0030	.0000	.20	1.1
19467	June 14	Slight.	Slight.	.20	10.30	3.20	.0072	.0180	.0134	.0046	4.20	.0090	.0001	.27	0.9
19831	July 19	Slight.	Slight.	.23	10.70	2.00	.0180	.0280	.0196	.0084	4.50	.0020	.0000	.31	0.8
20119	Aug. 16	Slight.	Slight.	.32	10.75	2.05	.0068	.0368	.0290	.0078	4.60	.0030	.0000	.36	0.8
20564	Sept. 20	V. slight.	V. slight.	.42	11.00	2.05	.0014	.0216	.0184	.0032	4.50	.0000	.0003	.30	1.4
20836	Oct. 18	Distinct.	Slight.	.40	10.95	1.85	.0002	.0272	.0190	.0082	4.43	.0400	.0000	.50	–
21239	Nov. 15	Decided.	Cons.	.32	10.35	2.50	.0006	.0344	.0210	.0134	4.75	.0020	.0000	.25	0.8
21615	Dec. 20	Slight.	Cons.	.20	10.80	2.15	.0006	.0232	.0188	.0044	4.99	.0060	.0000	.27	1.6

Averages by Years.

–	1894	–	–	.22	12.85	1.91	.0001	.0225	.0163	.0062	5.55	.0010	.0000	.25	1.3
–	1895	–	–	.25	12.61	2.31	.0025	.0302	.0198	.0104	5.42	.0037	.0000	.32	1.2
–	1896	–	–	.29	11.67	2.11	.0008	.0198	.0149	.0049	4.97	.0039	.0000	.24	1.0
–	1897	–	–	.30	10.94	2.10	.0034	.0251	.0196	.0055	4.60	.0058	.0000	.31	1.1

NOTE to analyses of 1897: Odor, generally distinctly vegetable and occasionally mouldy.—— The samples were collected from a faucet at the pumping station.

Microscopical Examination of Water from Cape Pond, Rockport.

[Number of organisms per cubic centimeter.]

	1897. Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
Day of examination,	21	18	23	14	18	16	21	18	21	20	16	22
Number of sample,	18288	18503	18821	18997	19261	19467	19831	20119	20564	20836	21239	21615
PLANTS.												
Diatomaceæ,	188	108	750	929	156	1,664	154	46	522	3,258	5,028	4,046
Asterionella,	124	92	748	915	144	1,272	2	4	34	2,920	5,000	4,000
Cyclotella,	0	0	0	1	0	0	0	0	144	0	0	2
Melosira,	64	16	0	9	12	348	152	38	340	272	28	44
Tabellaria,	0	0	0	0	0	0	0	0	0	66	0	0
Cyanophyceæ, Anabæna,	0	0	0	0	0	0	236	660	14	240	0	44
Algæ,	94	2	1	1	0	104	4	168	58	1,808	444	226
Protococcus,	92	0	1	0	0	36	2	66	24	82	16	10
Staurogenia,	0	0	0	0	0	20	0	58	22	1,688	408	208

Microscopical Examination of Water from Cape Pond, Rockport — Concluded.

[Number of organisms per cubic centimeter.]

	1897.											
	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
ANIMALS.												
Infusoria,	2	9	24	40	10	8	28	86	2	82	30	22
Ciliated infusorian,	0	0	0	0	0	0	0	0	0	18	0	0
Dinobryon,	0	9	23	40	1	0	0	0	0	0	0	6
Trachelomonas,	2	0	1	0	0	8	28	84	0	64	28	14
Uroglena,	0	0	0	0	9	0	0	0	0	0	0	0
Vermes, Anuraea,	6	1	3	3	0	0	0	0	0	0	0	2
Crustacea, Cyclops,	0	0	0	pr.	0	0	0	0	pr.	pr.	0	0
Miscellaneous, Zoöglœa,	120	10	20	20	5	100	180	40	5	15	0	10
TOTAL,	410	130	798	993	171	1,876	602	1,000	601	5,403	5,502	4,350

WATER SUPPLY OF RUTLAND.

Chemical Examination of Water from Muschopauge Lake, Rutland.

[Parts per 100,000.]

Number.	Date of Collection.	Appearance.			Residue on Evaporation.		Ammonia.				Chlorine.	Nitrogen as		Oxygen Consumed.	Hardness.
		Turbidity.	Sediment.	Color.	Total.	Loss on Ignition.	Free.	Albuminoid. Total.	Albuminoid. Dissolved.	Albuminoid. Suspended		Nitrates.	Nitrites.		
	1897.														
18479	Feb. 10	V. slight.	V. slight.	.03	2.10	0.70	.0044	.0154	.0154	.0000	.30	.0030	.0000	.14	0.5
18746	Mar. 9	V. slight.	V. slight.	.07	2.45	0.75	.0024	.0106	.0086	.0020	.20	.0050	.0000	.16	0.6
19190	May 8	None.	None.	.10	1.65	0.55	.0022	.0062	.0062	.0000	.15	.0150	.0001	.08	0.6
20300	Aug. 27	V. slight.	V. slight	.03	2.35	0.85	.0002	.0106	.0090	.0016	.13	.0020	.0000	.15	0.6
20816	Oct. 15	V. slight.	V. slight	.10	2.35	1.15	.0030	.0130	.0130	.0000	.13	.0020	.0001	.24	0.8
21314	Nov. 19	V. slight.	Slight.	.08	2.45	1.00	.0034	.0106	.0106	.0000	.16	.0020	.0000	.13	1.1
21464	Dec. 7	Slight.	Cons.	.10	2.35	0.60	.0008	.0128	.0106	.0022	.18	.0070	.0000	.10	1.4
Av...	....	....	....	.07	2.24	0.80	.0023	.0113	.0105	.0008	.18	.0051	.0000	.14	0.8

Odor, faintly vegetable or none. A faintly vegetable odor was developed in nearly all of the samples on heating. —— Nos. 18479, 18746 and 20300 were collected from the lake; the remaining samples, from a faucet at the pumping station.

Microscopical Examination.

The organism *Dinobryon* was found in the samples collected in February, March and May, the number found in each sample being 192, 544 and 1 per cubic centimeter, respectively.

SALEM.

Water Supply of Salem and Beverly.

Chemical Examination of Water from Wenham Lake, in Beverly and Wenham.

[Parts per 100,000.]

Number.	Date of Collection.	Appearance.			Residue on Evaporation.		Ammonia.				Chlorine.	Nitrogen as		Oxygen Consumed.	Hardness.
		Turbidity.	Sediment.	Color.	Total.	Loss on Ignition.	Free.	Albuminoid. Total.	Albuminoid. Dissolved.	Albuminoid. Suspended.		Nitrates.	Nitrites.		
	1897.														
18266	Jan. 18	V. slight.	Slight.	.12	7.85	1.80	.0036	.0160	.0138	.0022	.83	.0070	.0002	.21	2.9
18527	Feb. 17	None.	V. slight.	.05	6.05	1.40	.0054	.0144	.0136	.0008	.84	.0050	.0001	.18	2.9
18722	Mar. 9	V. slight.	V. slight.	.12	6.05	1.25	.0068	.0136	.0132	.0004	.90	.0100	.0001	.25	2.7
18976	Apr. 7	V. slight.	V. slight.	.20	5.55	1.85	.0012	.0122	.0106	.0016	.78	.0080	.0002	.28	2.5
19224	May 11	Slight.	Slight.	.15	5.50	1.25	.0012	.0258	.0224	.0034	.79	.0030	.0001	.27	2.6
19396	June 7	V. slight.	V. slight.	.20	6.10	1.80	.0010	.0366	.0262	.0104	.82	.0030	.0000	.47	2.2
19789	July 14	V. slight.	V. slight.	.17	5.95	1.65	.0002	.0240	.0156	.0084	.72	.0070	.0000	.40	2.3
20063	Aug. 10	Slight.	V. slight.	.13	5.75	1.40	.0008	.0204	.0144	.0060	.82	.0000	.0000	.32	2.5
20463	Sept. 13	V. slight.	V. slight.	.07	6.10	1.80	.0004	.0190	.0156	.0034	.79	.0020	.0000	.30	2.6
20766	Oct. 12	V. slight.	Slight.	.12	6.25	1.95	.0024	.0246	.0240	.0006	.82	.0020	.0000	.33	2.6
21097	Nov. 9	V. slight.	Cons.	.15	6.10	1.60	.0080	.0226	.0192	.0034	.90	.0050	.0002	.24	3.1
21720	Dec. 30	V. slight.	Slight.	.10	5.80	1.45	.0018	.0176	.0150	.0026	.86	.0060	.0000	.22	3.1

Averages by Years.

-	1887*	-	-	.05	4.73	0.82	.0025	.0135	-	-	.72	.0019	-	-	-
-	1888	-	-	.05	4.67	0.97	.0020	.0146	-	-	.73	.0058	.0001	-	-
-	1889	-	-	.06	4.23	1.05	.0014	.0173	.0138	.0035	.72	.0052	.0002	-	-
-	1890	-	-	.05	4.57	0.90	.0016	.0154	.0125	.0029	.74	.0104	.0001	-	2.5
-	1891	-	-	.07	4.70	1.12	.0006	.0147	.0113	.0034	.72	.0125	.0000	-	1.9
-	1892	-	-	.03	4.85	1.10	.0016	.0137	.0103	.0034	.75	.0077	.0000	-	2.2
-	1893	-	-	.04	5.49	1.26	.0033	.0130	.0100	.0030	.77	.0055	.0001	.16	2.6
-	1894	-	-	.07	6.69	1.53	.0030	.0148	.0114	.0034	.82	.0023	.0001	.14	3.0
-	1895	-	-	.21	6.75	1.97	.0026	.0177	.0146	.0031	.81	.0059	.0001	.30	3.1
-	1896	-	-	.15	6.30	1.82	.0020	.0213	.0152	.0061	.80	.0053	.0001	.28	2.7
-	1897	-	-	.13	6.09	1.60	.0027	.0206	.0170	.0036	.82	.0048	.0001	.29	2.7

* June to December.

Note to analyses of 1897: Odor, vegetable. —— Nos. 18266, 18527, 18722 and 21720 were collected from a faucet at the pumping station; the others, from the lake.

For monthly record of height of water in this lake, see page 293.

SALEM.

Microscopical Examination of Water from Wenham Lake, in Beverly and Wenham.

[Number of organisms per cubic centimeter.]

	1897.											1898.
	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Jan.
Day of examination,	19	20	11	9	13	10	17	12	14	13	11	3
Number of sample,	18266	18527	18722	18976	19224	19396	19789	20063	20463	20766	21097	21720
PLANTS.												
Diatomaceæ,	**492**	**272**	**150**	**700**	**2,280**	**444**	**135**	**340**	**862**	**366**	**592**	**1,208**
Asterionella,	332	156	84	260	2,048	204	0	216	772	236	168	180
Cyclotella,	0	100	36	0	0	88	0	0	2	12	48	224
Cymbella,	76	0	0	0	1	0	0	0	0	0	0	0
Fragilaria,	2	0	0	0	0	0	3	38	60	34	8	17
Melosira,	76	13	26	0	138	66	16	0	20	42	212	152
Meridion,	0	0	0	360	0	0	0	0	0	0	0	0
Stephanodiscus,	0	0	0	60	45	0	108	0	0	0	0	0
Tabellaria,	4	0	2	6	0	86	4	86	0	38	156	632
Cyanophyceæ,	**3**	**0**	**0**	**0**	**1**	**36**	**90**	**84**	**98**	**14**	**8**	**0**
Anabæna,	0	0	0	0	0	4	4	66	56	2	0	0
Cœlosphærium,	0	0	0	0	1	0	2	14	0	4	8	0
Microcystis,	3	0	0	0	0	32	84	0	40	8	0	0
Algæ,	**0**	**0**	**2**	**0**	**1**	**6**	**15**	**42**	**84**	**18**	**2**	**4**
Protococcus,	0	0	2	0	1	6	8	40	60	8	0	0
ANIMALS.												
Rhizopoda, Actinophrys,	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**4**	**4**	**0**	**0**
Infusoria,	**7**	**0**	**2**	**23**	**1,154**	**4**	**1**	**2**	**58**	**6**	**1**	**2**
Dinobryon,	6	0	0	13	1,152	0	0	0	54	2	0	0
Vermes,	**0**	**0**	**0**	**0**	**2**	**1**	**0**	**0**	**0**	**0**	**0**	**1**
Crustacea,	**0**	**0**	**0**	**pr.**	**0**	**0**	**0**	**0**	**0**	**pr.**	**pr.**	**0**
Miscellaneous, Zoöglœa,	**10**	**30**	**10**	**40**	**20**	**80**	**40**	**15**	**0**	**40**	**15**	**10**
TOTAL,	512	302	164	763	3,458	571	281	483	1,106	448	618	1,225

SALEM.

Chemical Examination of Water from Longham Brook Reservoir, in Beverly and Wenham.

[Parts per 100,000.]

Number.	Date of Collection.	Appearance.			Residue on Evaporation.		Ammonia.				Chlorine.	Nitrogen as		Oxygen Consumed.	Hardness.
								Albuminoid.							
		Turbidity.	Sediment.	Color.	Total.	Loss on Ignition.	Free.	Total.	Dissolved.	Suspended		Nitrates.	Nitrites.		
	1897.														
18265	Jan. 18	Slight.	Slight.	0.90	6.75	2.30	.0052	.0406	.0332	.0074	0.83	.0150	.0002	0.79	1.6
18528	Feb. 17	V. slight.	V. slight.	0.72	5.65	2.40	.0094	.0278	.0264	.0014	1.14	.0100	.0001	0.71	1.7
18723	Mar. 9	Distinct.	Slight.	0.85	4.45	1.95	.0106	.0360	.0312	.0048	0.62	.0050	.0001	0.70	0.9
18977	Apr. 7	Slight.	Slight.	0.75	4.00	1.90	.0022	.0334	.0282	.0052	0.74	.0030	.0002	0.68	0.9
19397	June 7	Slight.	V. slight.	2.00	6.35	3.25	.0294	.0622	.0538	.0084	0.76	.0050	.0001	1.32	1.6
19790	July 14	V. slight.	Slight.	3.84	8.25	3.65	.0158	.0652	.0556	.0096	0.78	.0020	.0000	2.27	1.7
20064	Aug. 10	Slight.	V. slight.	2.90	8.35	3.60	.0034	.0632	.0522	.0110	0.86	.0020	.0000	1.57	1.7
20464	Sept. 13	Slight.	Cons.	2.70	8.15	4.05	.0012	.0812	.0516	.0296	0.86	.0030	.0000	1.32	1.9
20765	Oct. 12	V. slight.	Slight.	2.20	7.25	3.60	.0086	.0528	.0454	.0074	0.93	.0170	.0010	1.14	1.3
21096	Nov. 9	Decided.	Cons.	1.50	8.10	3.35	.0348	.0496	.0438	.0058	1.20	.0170	.0007	1.05	2.2
21719	Dec. 30	Slight.	Cons.	1.80	9.55	3.55	.0190	.0428	.0356	.0072	1.60	.0290	.0001	1.36	2.9
Av.	....	....	....	1.83	6.99	3.05	.0127	.0504	.0415	.0089	0.94	.0098	.0002	1.17	1.7

Odor, generally distinctly vegetable, occasionally mouldy. —— The samples were collected from the reservoir.

Microscopical Examination of Water from Longham Brook Reservoir, in Beverly and Wenham.

[Number of organisms per cubic centimeter.]

	1897.										1898.
	Jan.	Feb.	Mar.	Apr.	June.	July.	Aug.	Sept.	Oct.	Nov.	Jan.
Day of examination,	19	20	11	9	10	17	12	14	13	11	3
Number of sample,	18265	18528	18723	18977	19397	19790	20064	20464	20765	21096	21719
PLANTS.											
Diatomaceæ,	0	2	10	126	2	2	8	24	10	12	0
Tabellaria,	0	0	0	76	0	0	8	0	0	0	0
Algæ,	0	4	0	0	1	10	69	8	0	0	0
Fungi, Crenothrix,	0	0	0	0	0	0	60	0	0	0	0

SALEM.

Microscopical Examination of Water from Longham Brook Reservoir, in Beverly and Wenham — Concluded.

[Number of organisms per cubic centimeter.]

	1897.										1898.
	Jan.	Feb.	Mar.	Apr.	June.	July	Aug.	Sept.	Oct.	Nov.	Jan.
ANIMALS.											
Infusoria,	167	2	46	34	19	12	880	524	2	2	3
Dinobryon,	6	0	0	31	13	0	844	0	0	0	0
Euglena,	0	0	0	0	0	0	6	522	0	0	0
Peridinium,	160	2	0	0	0	0	0	2	0	0	0
Raphidomonas,	0	0	16	0	0	0	0	0	0	0	0
Synura,	1	0	12	0	0	0	0	0	0	0	0
Trachelomonas,	0	0	18	0	1	12	20	0	1	0	3
Vermes,	0	0	2	0	1	0	8	6	1	2	0
Crustacea,	0	0	0	pr.	0	pr.	0	pr.	0	0	0
Miscellaneous, Zoöglœa,	60	60	70	80	120	0	160	15	60	25	25
TOTAL,	227	68	128	240	143	24	1205	577	73	41	28

Table showing Heights of Water in Wenham Lake on the First of Each Month in 1897.

[NOTE. — High-water mark is 30.17 feet.]

DATE.	Height of Water.	DATE.	Height of Water.
1897.	Feet.	1897.	Feet.
Jan. 1,	25.29	July 1,	29.62
Feb. 1,	25.71	Aug. 1,	28.92
March 1,	25.92	Sept. 1,	28.17
April 1,	29.42	Oct. 1,	27.12
May 1,	30.00	Nov. 1,	26.08
June 1,	29.92	Dec. 1,	26.21

WATER SUPPLY OF SAUGUS.

(See *Lynn*.)

WATER SUPPLY OF SHARON.

Chemical Examination of Water from the Well of the Sharon Water Works.

[Parts per 100,000.]

Number.	Date of Collection.	Appearance.			Residue on Evaporation.	Ammonia.		Chlorine.	Nitrogen as		Oxygen Consumed.	Hardness.	Iron.
		Turbidity.	Sediment.	Color.		Free.	Albuminoid.		Nitrates.	Nitrites.			
20011	1897. Aug. 5	None.	None.	.02	9.40	.0000	.0004	1.03	.1900	.0000	.00	3.1	.0030

Odor, none. —— The sample was collected from a faucet at the pumping station, while pumping.

SHEFFIELD.

Water Supply of Sheffield. — Sheffield Water Company.

Population in 1895, 1,897. The works are owned by the Sheffield Water Company, and were completed in October, 1897. The sources of supply are two small reservoirs about a mile and a half north-east of the village of Sheffield. The upper reservoir is located on a small brook fed principally by springs. The lower reservoir is fed by a large spring on a hillside. Water is supplied to the town by gravity. Service pipes are of galvanized iron.

The advice of the State Board of Health to the Sheffield Water Company, with reference to the use of these sources for the supply of the town, may be found on pages 39 and 40 of the annual report for the year 1896, and on page 46 of the annual report for the year 1895.

Chemical Examination of Water from the Spring or Lower Reservoir of the Sheffield Water Company.

[Parts per 100,000.]

Number.	Date of Collection.	Appearance.			Residue on Evaporation.	Ammonia.		Chlorine.	Nitrogen as		Oxygen Consumed.	Hardness.	Iron.
		Turbidity.	Sediment.	Color.		Free.	Albuminoid.		Nitrates.	Nitrites.			
21256	1897. Nov. 16	None.	None.	.01	3.30	.0004	.0016	.09	.0130	.0000	.02	1.8	.0010

Odor, none. —— The sample was collected from the reservoir.

Chemical Examination of Water from the Upper Reservoir of the Sheffield Water Company.

[Parts per 100,000.]

Number.	Date of Collection.	Appearance.			Residue on Evaporation.		Ammonia.				Chlorine.	Nitrogen as		Oxygen Consumed.	Hardness.
								Albuminoid.							
		Turbidity.	Sediment.	Color.	Total.	Loss on Ignition.	Free.	Total.	Dissolved.	Suspended.		Nitrates.	Nitrites.		
21255	1897. Nov. 16	None.	Slight.	.19	3.60	1.20	.0006	.0060	.0048	.0012	.15	.0020	.0000	.19	2.0

Odor, faintly earthy. —— The sample was collected from the reservoir.

SHEFFIELD.

Chemical Examination of Water from a Faucet in Sheffield, supplied from the Works of the Sheffield Water Company.

[Parts per 100,000.]

Number.	Date of Collection.	Appearance.			Residue on Evaporation.	Ammonia.		Chlorine.	Nitrogen as		Oxygen Consumed.	Hardness.	Iron.
		Turbidity.	Sediment.	Color.		Free.	Albuminoid.		Nitrates.	Nitrites.			
	1897.												
21257	Nov. 16	None.	None.	.06	5.60	.0018	.0022	.10	.0120	.0000	.04	3.6	.0070

Odor, faintly earthy.

Massachusetts Reformatory Prison for Women, Sherborn.

The advice of the State Board of Health to the Superintendent of the Massachusetts Reformatory Prison for Women, relative to the quality of the water supplied to that institution, may be found on pages 27 and 28 of this volume. The results of analyses of samples of water collected from Waushakum Pond, the source of water supply of the prison, are given in the following table: —

Chemical Examination of Water from Waushakum Pond.

[Parts per 100,000.]

Number.	Date of Collection.	Appearance.			Residue on Evaporation.		Ammonia.				Chlorine.	Nitrogen as		Oxygen Consumed.	Hardness.
								Albuminoid.							
		Turbidity.	Sediment.	Color.	Total.	Loss on Ignition.	Free.	Total.	Dissolved.	Suspended.		Nitrates.	Nitrites.		
	1897.														
20893	Oct. 19	V. slight.	V. slight.	.10	3.85	1.75	.0000	.0196	.0156	.0040	.35	.0350	.0000	.41	1.6
20894	Oct. 19	None.	None.	.30	4.00	1.90	.0006	.0184	.0170	.0014	.35	.0100	.0000	.44	1.6

Odor, faintly vegetable, becoming distinctly vegetable on heating. —— The first sample was collected from the easterly side of the pond, near the point from which the water supply for the Reformatory Prison for Women is taken; the second, from the southerly side of the pond, near a large picnic ground, and about 500 feet from the point from which water is drawn for the supply of the prison.

Microscopical Examination.

No. 20893. Diatomaceæ, *Asterionella*, 22; *Navicula*, 2; *Tabellaria*, 16. Cyanophyceæ, *Anabæna*, 4; *Cœlosphærium*, 8; *Microcystis*, 12. Algæ, *Raphidium*, 8. Infusoria, *Dinobryon*, 6. Total, 78.

No. 20894. Diatomaceæ, *Asterionella*, 32; *Melosira*, 14; *Navicula*, 2; *Synedra*, 4; *Tabellaria*, 16. Cyanophyceæ, *Anabæna*, 6; *Cœlosphærium*, 6. Algæ, *Protococcus*, 6; *Raphidium*, 8. Infusoria, *Trachelomonas*, 12. Vermes, *Asplanchna*, 2. Crustacea, *Cyclops*, pr. Total, 96.

SOMERVILLE.

WATER SUPPLY OF SOMERVILLE.

(See *Boston, Mystic Works.*)

WATER SUPPLY OF SOUTHBRIDGE. — SOUTHBRIDGE WATER SUPPLY COMPANY.

Chemical Examination of Water from the Hatchet Brook Reservoir of the Southbridge Water Works.

[Parts per 100,000.]

Number.	Date of Collection.	Appearance.			Residue on Evaporation.		Ammonia.				Chlorine.	Nitrogen as		Oxygen Consumed.	Hardness.
								Albuminoid.							
		Turbidity.	Sediment.	Color.	Total.	Loss on Ignition.	Free.	Total.	Dissolved.	Suspended.		Nitrates.	Nitrites.		
	1897.														
18362	Jan. 26	V. slight.	Slight.	0.60	3.85	1.55	.0028	.0270	.0258	.0012	.22	.0080	.0000	.64	1.3
18468	Feb. 9	Slight.	Cons.	0.65	3.80	1.55	.0026	.0244	.0196	.0048	.20	.0050	.0000	.57	1.1
18737	Mar. 9	V. slight.	V. slight.	0.70	3.50	1.60	.0068	.0208	.0194	.0014	.20	.0030	.0000	.62	1.3
19026	Apr. 12	V. slight.	V. slight.	0.40	3.15	1.20	.0006	.0136	.0110	.0026	.13	.0030	.0000	.50	0.3
19216	May 11	V. slight.	Cons.	0.42	2.65	1.00	.0004	.0186	.0138	.0048	.17	.0030	.0000	.45	0.5
19417	June 8	Slight.	Cons.	0.50	3.05	1.40	.0026	.0238	.0216	.0022	.08	.0000	.0000	.63	1.0
19784	July 13	Slight.	Slight.	1.00	3.55	1.70	.0074	.0226	.0214	.0012	.11	.0020	.0000	.83	0.8
20067	Aug. 10	V. slight.	Slight.	1.09	3.90	2.30	.0030	.0236	.0200	.0036	.16	.0020	.0000	.99	0.8
20485	Sept. 14	V. slight.	V. slight.	0.70	3.30	1.45	.0008	.0260	.0244	.0016	.16	.0000	.0000	.77	1.1
20769	Oct. 12	Slight.	Cons.	0.92	3.80	2.15	.0008	.0332	.0204	.0128	.17	.0000	.0000	.69	0.6
21093	Nov. 9	V. slight.	V. slight.	0.92	4.20	2.15	.0052	.0326	.0318	.0008	.26	.0050	.0001	.79	1.3
21565	Dec. 14	V. slight.	V. slight.	0.70	3.60	1.90	.0064	.0212	.0212	.0000	.23	.0050	.0000	.65	1.3
Av...	....	....	....	0.72	3.53	1.66	.0033	.0240	.0209	.0031	.17	.0030	.0000	.68	0.9

Odor in October and November, fishy; at other times, vegetable. —— The samples were collected from the reservoir which is known as Reservoir No. 3.

Microscopical Examination.

The organism *Synura* was found in the samples collected in October and November, the number found in each sample being 88 and 60 per cubic centimeter, respectively.

SOUTHBRIDGE.

Chemical Examination of Water from Glover Spring, Southbridge.

[Parts per 100,000.]

Number.	Date of Collection.	Appearance.			Residue on Evaporation.	Ammonia.		Chlorine.	Nitrogen as		Oxygen Consumed.	Hardness.	Iron.
		Turbidity.	Sediment.	Color.		Free.	Albuminoid.		Nitrates.	Nitrites.			
	1897.												
20768	Oct. 12	Slight, milky.	Slight.	.75	5.00	.0002	.0012	.18	.0020	.0000	.06	2.9	.0030

Odor, faintly earthy.——The sample was collected from a faucet in Southbridge, supplied with water from Glover Spring. This spring is used as a source of supply for several families.

Water Supply of South Hadley Falls Fire District, South Hadley.

Chemical Examination of Water from a Faucet, supplied from the South Hadley Water Works.

[Parts per 100,000.]

Number.	Date of Collection.	Appearance.			Residue on Evaporation.		Ammonia.				Chlorine.	Nitrogen as		Oxygen Consumed.	Hardness.
								Albuminoid							
		Turbidity.	Sediment.	Color.	Total.	Loss on Ignition.	Free.	Total.	Dissolved.	Suspended.		Nitrates.	Nitrites.		
	1897.														
18478	Feb. 10	Slight.	V. slight.	.20	3.60	1.15	.0152	.0162	.0154	.0008	.24	.0270	.0000	.22	0.9
19199	May 10	V. slight.	V. slight.	.18	3.25	0.70	.0000	.0038	.0034	.0004	.17	.0270	.0000	.10	0.8
19735	July 7	Distinct.	Cons.	.33	3.60	1.05	.0014	.0144	.0072	.0072	.18	.0220	.0000	.32	0.8
20033	Aug. 9	None.	V. slight.	.42	3.95	1.30	.0008	.0088	.0076	.0012	.19	.0400	.0000	.27	0.8
21103	Nov. 8	Slight.	V. slight.	.40	3.85	1.15	.0008	.0094	.0094	.0000	.22	.0380	.0001	.24	2.3

Odor of the last sample, none; of the others, faintly vegetable.——The first sample was collected from Buttery Brook Reservoir; the remaining samples were collected from a faucet in South Hadley, and represent a mixture of water from the Buttery Brook and Leaping Well Reservoirs.

SPRINGFIELD.

Water Supply of Springfield and Ludlow.

The advice of the State Board of Health to the city of Springfield, with reference to securing an additional supply of water from Loon and Five Mile ponds, and with regard to the best method of improving the quality of the water of Ludlow Reservoir, one of the present sources of supply, may be found on pages 37 to 42 of this volume.

Chemical Examination of Water from the Receiving Basin of the Springfield Water Works, at Ludlow.

[Parts per 100,000.]

Number.	Date of Collection.	Appearance.			Residue on Evaporation.		Ammonia.				Chlorine.	Nitrogen as		Oxygen Consumed.	Hardness.
		Turbidity.	Sediment.	Color.	Total.	Loss on Ignition.	Free.	Albuminoid. Total.	Albuminoid. Dissolved.	Albuminoid. Suspended.		Nitrates.	Nitrites.		
	1897.														
18365	Jan. 26	Slight.	Slight.	.40	3.60	1.35	.0008	.0142	.0134	.0008	.20	.0150	.0000	.42	0.9
18449	Feb. 8	Slight.	Slight.	.28	2.85	0.85	.0032	.0144	.0126	.0018	.17	.0100	.0001	.35	0.8
18743	Mar. 9	Slight.	Slight.	.42	2.80	1.05	.0026	.0206	.0178	.0028	.15	.0080	.0000	.45	0.5
19004	Apr. 12	V. slight.	Slight.	.55	2.85	1.30	.0004	.0182	.0166	.0016	.14	.0030	.0000	.59	0.6
19180	May 5	V. slight.	Cons.	.43	3.20	0.90	.0014	.0162	.0134	.0028	.14	.0030	.0000	.49	1.1
19398	June 7	Slight.	Slight.	.63	3.45	1.55	.0002	.0208	.0150	.0058	.08	.0030	.0000	.56	1.1
19748	July 8	Slight.	Slight.	.55	3.25	1.50	.0004	.0196	.0122	.0074	.12	.0020	.0000	.56	1.1
20027	Aug. 9	V. slight.	Slight.	.52	3.80	1.70	.0006	.0190	.0178	.0012	.15	.0000	.0000	.58	1.1
20400	Sept. 8	V. slight.	V. slight.	.50	4.20	1.50	.0010	.0166	.0136	.0030	.17	.0020	.0000	.55	1.3
20736	Oct. 6	Slight.	Slight.	.48	3.70	1.55	.0004	.0252	.0162	.0090	.13	.0030	.0000	.44	1.0
21067	Nov. 8	Decided.	Decided.	.86	4.50	2.15	.0012	.0218	.0218	.0000	.24	.0040	.0002	.70	1.6
21487	Dec. 8	V. slight.	V. slight.	.50	3.70	1.35	.0032	.0154	.0142	.0012	.20	.0080	.0001	.49	1.3

Averages by Years.

-	1891	-	-	.31	3.27	1.20	.0011	.0225	.0147	.0078	.09	.0049	.0001	-	1.0
-	1892	-	-	.44	3.79	1.39	.0004	.0164	.0127	.0037	.14	.0089	.0001	-	1.3
-	1893	-	-	.49	3.76	1.39	.0009	.0204	.0146	.0058	.15	.0026	.0001	.51	1.2
-	1894	-	-	.49	3.68	1.42	.0010	.0196	.0151	.0045	.16	.0027	.0000	.46	1.6
-	1895	-	-	.47	3.86	1.61	.0019	.0212	.0162	.0050	.18	.0050	.0000	.50	1.3
-	1896	-	-	.43	3.71	1.37	.0012	.0182	.0150	.0032	.15	.0051	.0000	.50	1.1
-	1897	-	-	.51	3.49	1.40	.0013	.0185	.0154	.0031	.16	.0051	.0000	.51	1.0

NOTE to analyses of 1897: Odor, generally distinctly vegetable, occasionally grassy.——The samples were collected from the basin, near the surface.

SPRINGFIELD.

Chemical Examination of Water from Ludlow Reservoir.

[Parts per 100,000.]

Number.	Date of Collection.	Appearance.			Residue on Evaporation.		Ammonia.				Chlorine.	Nitrogen as		Oxygen Consumed.	Hardness.
		Turbidity.	Sediment.	Color.	Total.	Loss on Ignition.	Free.	Albuminoid. Total.	Albuminoid. Dissolved.	Albuminoid. Suspended.		Nitrates.	Nitrites.		
	1897.														
18366	Jan. 26	Slight.	Slight.	.22	3.50	1.75	.0000	.0358	.0320	.0038	.19	.0080	.0000	.40	0.6
18450	Feb. 8	Slight.	Slight.	.20	3.15	1.50	.0036	.0314	.0230	.0084	.20	.0050	.0001	.32	0.8
18741	Mar. 9	Slight.	Slight.	.25	3.00	1.35	.0010	.0300	.0202	.0098	.18	.0070	.0000	.41	0.6
19005	Apr. 12	Slight.	Slight.	.30	2.70	1.40	.0004	.0186	.0130	.0056	.14	.0000	.0001	.39	0.6
19181	May 5	V. slight.	Slight.	.18	2.60	1.10	.0004	.0210	.0156	.0054	.14	.0000	.0000	.32	0.9
19399	June 7	Distinct.	Slight.	.40	2.65	1.50	.0008	.0398	.0128	.0270	.10	.0030	.0000	.41	0.5
19749	July 8	V. slight.	Slight.	.37	2.95	1.70	.0378	.0400	.0360	.0040	.13	.0050	.0000	.50	0.6
20028	Aug. 9	Decided, green.	Cons.	.48	3.85	2.10	.0006	.1052	.0344	.0708	.14	.0000	.0000	.55	0.9
20398	Sept. 8	Distinct.	Slight.	.40	3.85	1.60	.0000	.0584	.0242	.0342	.15	.0020	.0000	.61	0.6
20734	Oct. 6	Slight.	Slight.	.40	3.85	2.10	.0004	.0660	.0378	.0282	.12	.0020	.0000	.44	0.8
21068	Nov. 8	Slight.	Cons.	.31	3.55	2.10	.0004	.0586	.0398	.0188	.15	.0000	.0000	.38	1.3
21488	Dec. 8	Slight.	Slight.	.40	3.75	1.90	.0012	.0390	.0314	.0070	.19	.0020	.0001	.43	1.1

Averages by Years.

-	1876-77*	-	-	-	4.86	-	.0139	.0426	.0296	.0130	-	-	-	-	-
-	1887†	-	-	.24	3.63	1.65	.0030	.0486	-	-	.15	.0019	-	-	-
-	1888	-	-	.13	2.91	1.20	.0019	.0332	-	-	.12	.0047	.0001	-	-
-	1889	-	-	.12	2.42	1.08	.0028	.0461	.0237	.0224	.10	.0033	.0002	-	-
-	1890	-	-	.15	2.96	1.54	.0029	.0387	.0210	.0177	.10	.0065	.0001	-	0.9
-	1891	-	-	.20	3.00	1.42	.0050	.0425	.0228	.0197	.09	.0050	.0001	-	0.8
-	1892‡	-	-	.25	3.41	1.41	.0006	.0277	.0189	.0088	.13	.0049	.0001	-	1.0
-	1893§	-	-	.47	4.11	2.03	.0011	.0375	.0259	.0116	.14	.0019	.0001	.58	1.2
-	1894	-	-	.37	3.39	1.47	.0009	.0221	.0165	.0056	.16	.0018	.0000	.42	1.1
-	1895	-	-	.29	3.35	1.55	.0028	.0315	.0201	.0114	.18	.0030	.0000	.41	1.1
-	1896	-	-	.26	3.25	1.41	.0042	.0404	.0220	.0184	.15	.0031	.0000	.37	1.0
-	1897	-	-	.33	3.28	1.67	.0039	.0453	.0267	.0186	.15	.0028	.0000	.43	0.8

* These analyses were made by Prof. William R. Nichols, for the city of Springfield, from samples collected about once a week, between July 1, 1876, and Sept. 30, 1877.

† June to December. ‡ January to September. § May to December.

NOTE to analyses of 1897: Odor, distinctly vegetable and mouldy or grassy. The iron was determined in nine samples, the average amount in parts per 100,000 being .0176. —— The samples were collected from the reservoir, near the surface. For monthly record of height of water, see page 305.

SPRINGFIELD.

Microscopical Examination of Water from Ludlow Reservoir.

[Number of organisms per cubic centimeter.]

	1897.											
	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
Day of examination,	30	10	13	14	8	8	9	11	9	8	9	9
Number of sample,	18366	18450	18741	19005	19181	19399	19749	20028	20398	20734	21068	21488
PLANTS.												
Diatomaceæ,	128	61	180	171	320	192	10	6	132	120	80	666
Asterionella,	8	6	84	88	124	84	8	0	8	2	42	608
Fragilaria,	0	0	0	0	0	52	0	0	0	58	12	6
Melosira,	52	38	22	8	0	42	0	0	112	50	14	20
Meridion,	0	0	0	0	156	0	2	0	0	0	0	0
Synedra,	52	8	72	72	40	14	0	6	8	8	0	20
Cyanophyceæ,	0	0	3	20	18	1,942	40	3,048	1,576	1,130	430	24
Anabæna,	0	0	0	1	4	1,664	28	1,464	40	6	10	0
Clathrocystis,	0	0	0	1	0	6	4	16	0	4	4	0
Cœlosphærium,	0	0	3	18	14	272	8	1,568	1,536	1,120	416	24
Algæ,	120	10	2	13	205	70	14	108	36	62	80	8
Scenedesmus,	96	8	2	4	192	40	12	56	12	14	18	6
ANIMALS.												
Rhizopoda,	8	0	0	0	0	0	0	0	0	0	2	2
Infusoria,	60	92	554	62	83	4	0	2	8	46	18	20
Dinobryon,	40	88	552	55	81	0	0	0	0	28	6	16
Trachelomonas,	8	0	0	3	1	0	0	0	0	14	6	0
Vermes,	2	4	0	1	0	0	6	4	0	2	4	2
Crustacea,	pr.	0	0	0	0	pr.	pr.	0	0	0	0	0
Miscellaneous, Zoöglœa,	120	40	60	20	40	0	5	10	16	5	10	10
TOTAL,	438	207	799	287	666	2,208	75	3,178	1,768	1,365	624	732

SPRINGFIELD.

Chemical Examination of Water from Ludlow Reservoir, collected near the Bottom.

[Parts per 100,000.]

Number.	Date of Collection.	Appearance.			Residue on Evaporation.		Ammonia.				Chlorine.	Nitrogen as		Oxygen Consumed.	Hardness.
								Albuminoid							
		Turbidity.	Sediment.	Color.	Total.	Loss on Ignition	Free.	Total.	Dissolved.	Sus-pended.		Nitrates.	Nitrites.		
	1897.														
18367	Jan. 26	Slight.	V. slight.	.22	3.40	1.75	.0008	.0446	.0262	.0184	.18	.0030	.0000	.41	0.6
18451	Feb. 8	Slight.	Slight.	.20	3.15	1.50	.0052	.0300	.0232	.0068	.22	.0070	.0001	.40	0.8
18742	Mar. 9	Slight.	V. slight.	.30	3.05	1.25	.0010	.0316	.0232	.0084	.19	.0070	.0000	.41	0.8
19006	Apr. 12	Slight.	Slight.	.25	2.60	1.25	.0004	.0216	.0136	.0080	.13	.0000	.0000	.40	0.6
19182	May 5	V slight.	Cons.	.20	2.40	1.00	.0018	.0276	.0150	.0126	.12	.0030	.0000	.34	0.9
19400	June 7	Distinct.	Slight.	.40	2.90	1.45	.0008	.0460	.0106	.0354	.10	.0030	.0000	.40	0.5
19750	July 8	V. slight.	Slight.	.38	2.95	1.65	.0408	.0374	.0336	.0038	.13	.0030	.0000	.50	1.0
20029	Aug. 9	Decided, green.	Cons.	.48	3.80	2.00	.0010	.0926	.0322	.0604	.12	.0000	.0000	.54	0.6
20399	Sept. 8	Distinct.	Slight.	.43	3.75	1.55	.0002	.0574	.0260	.0314	.14	.0000	.0000	.55	1.0
20735	Oct. 6	Slight.	Slight.	.38	4.10	2.20	.0000	.0794	.0304	.0490	.11	.0020	.0000	.44	0.6
21069	Nov. 8	Slight.	Cons.	.31	3.65	2.15	.0006	.0608	.0386	.0222	.16	.0020	.0001	.41	1.1
21489	Dec. 8	Slight.	Slight.	.30	3.70	2.10	.0002	.0388	.0324	.0064	.18	.0030	.0001	.38	1.1
Av...	....	....	....	.32	3.29	1.65	.0044	.0473	.0254	.0219	.15	.0027	.0000	.43	1.8

Odor, generally distinctly vegetable and grassy, occasionally mouldy or unpleasant. The iron was determined in nine samples, the average amount in parts per 100,000 being .0162. —— The samples were collected from the reservoir, near the bottom.

Microscopical Examination of Water from Ludlow Reservoir, collected near the Bottom.

[Number of organisms per cubic centimeter.]

	1897.											
	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
Day of examination, . . .	30	10	13	14	8	8	9	11	9	8	9	9
Number of sample, . . .	18367	18451	18742	19006	19182	19400	19750	20029	20399	20735	21069	21489
PLANTS.												
Diatomaceæ, ...	**220**	**94**	**180**	**236**	**558**	**127**	**0**	**7**	**120**	**222**	**92**	**494**
Asterionella, ...	40	16	112	148	220	36	0	0	44	26	44	440
Fragilaria, ...	0	0	0	0	0	62	0	0	0	14	36	6
Melosira, ...	152	12	16	42	240	0	0	2	64	160	0	0
Synedra, ...	16	52	52	28	88	2	0	2	0	14	6	22
Cyanophyceæ, ...	**0**	**1**	**5**	**24**	**39**	**1,782**	**41**	**1,474**	**732**	**1,092**	**534**	**20**
Anabæna, ...	0	0	0	1	14	1,528	40	328	4	12	10	0
Clathrocystis, ...	0	0	0	0	1	0	0	10	12	4	0	2
Cœlosphærium, ...	0	1	5	23	24	252	1	1,136	712	1,076	524	18
Microcystis, ...	0	0	0	0	0	2	0	0	4	0	0	0
Algæ, ...	**40**	**36**	**4**	**22**	**230**	**23**	**22**	**57**	**124**	**42**	**66**	**18**
Protococcus, ...	8	8	0	6	14	7	0	0	84	0	0	0
Scenedesmus, ...	20	12	4	14	204	12	12	52	8	12	12	6

SPRINGFIELD.

Microscopical Examination of Water from Ludlow Reservoir, collected near the Bottom — Concluded.

[Number of organisms per cubic centimeter.]

	1897.											
	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
ANIMALS.												
Infusoria,	140	68	218	30	475	30	0	0	4	4	46	32
Dinobryon,	136	66	202	16	470	28	0	0	0	0	32	18
Peridinium,	4	0	0	10	2	0	0	0	0	0	0	8
Trachelomonas,	0	0	8	4	0	0	0	0	0	2	10	0
Vermes,	12	10	8	0	0	0	4	2	0	0	4	2
Crustacea,	0	0	0	0	pr.	pr.	pr.	pr.	0	pr.	pr.	pr.
Miscellaneous, Zoöglœa,	120	50	100	25	180	0	15	60	10	160	15	10
TOTAL,	532	259	515	337	1,482	1,962	82	1,600	990	1,520	757	576

Chemical Examination of Water from Chapin Pond, Ludlow.

[Parts per 100,000.]

Number.	Date of Collection.	Appearance.			Residue on Evaporation.		Ammonia.				Chlorine.	Nitrogen as		Oxygen Consumed.	Hardness.
		Turbidity.	Sediment.	Color.	Total.	Loss on Ignition.	Free.	Albuminoid. Total.	Albuminoid. Dissolved.	Albuminoid. Suspended.		Nitrates.	Nitrites.		
	1897.														
18369	Jan. 26	V. slight.	V. slight.	.10	3.10	1.15	.0010	.0212	.0182	.0030	.14	.0030	.0000	.36	0.8
18453	Feb. 8	V. slight.	Slight.	.05	1.95	0.50	.0054	.0128	.0116	.0012	.14	.0030	.0000	.09	0.5
18745	Mar. 8	V. slight.	V. slight.	.07	3.05	0.75	.0024	.0170	.0146	.0024	.18	.0030	.0000	.24	0.5
19184	May 5	V. slight.	Cons.	.12	2.20	0.65	.0016	.0174	.0152	.0022	.13	.0030	.0000	.23	0.6
19401	June 7	Slight.	Slight.	.20	2.20	1.10	.0004	.0206	.0166	.0040	.07	.0000	.0000	.32	0.6
19747	July 8	V. slight.	V. slight.	.12	1.75	0.70	.0000	.0170	.0136	.0034	.14	.0030	.0000	.36	0.6
20031	Aug. 9	V. slight.	Slight.	.12	2.00	0.95	.0006	.0200	.0152	.0048	.12	.0030	.0000	.31	0.5
20401	Sept. 8	V. slight.	V. slight.	.06	2.45	1.10	.0002	.0172	.0140	.0032	.11	.0020	.0000	.28	0.6
20738	Oct. 6	V. slight.	Slight.	.12	2.40	1.15	.0002	.0220	.0220	.0000	.09	.0030	.0000	.32	0.3
21070	Nov. 8	Slight.	Slight.	.09	2.45	1.25	.0032	.0260	.0208	.0052	.13	.0020	.0000	.29	1.0
21486	Dec. 8	V. slight.	V. slight.	.17	2.60	1.25	.0062	.0256	.0222	.0034	.16	.0050	.0001	.27	0.8
Av...	1897	....	....	.12	2,38	0.96	.0019	.0197	.0167	.0030	.13	.0027	.0000	.28	0.6
Av...	1896*	....	....	.03	2.60	0.99	.0005	.0196	.0144	.0052	.12	.0016	.0000	.18	0.4

* July to December.

NOTE to analyses of 1897: Odor, generally faintly vegetable, becoming distinctly vegetable on heating. In June, the odor became distinctly fishy on heating; and in November and December, distinctly grassy. —— The samples were collected from the pond, near the surface.

SPRINGFIELD.

Microscopical Examination of Water from Chapin Pond, Ludlow.

[Number of organisms per cubic centimeter.]

	1897. Jan.	Feb.	Mar.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
Day of examination,	30	10	13	8	8	9	11	9	8	9	9
Number of sample,	18369	18453	18745	19184	19401	19747	20031	20401	20738	21070	21486
PLANTS.											
Diatomaceæ,	28	0	26	124	276	45	27	19	26	42	76
Asterionella,	0	0	18	0	0	0	0	19	20	14	56
Tabellaria,	0	0	0	72	260	25	25	0	3	24	14
Cyanophyceæ,	0	0	0	0	88	13	0	0	0	226	4
Anabæna,	0	0	0	0	88	0	0	0	0	208	2
Merismopœdia,	0	0	0	0	0	0	0	0	0	16	0
Microcystis,	0	0	0	0	0	13	0	0	0	2	2
Algæ,	0	0	12	0	5	0	0	0	2	78	15
Raphidium,	0	0	12	0	1	0	0	0	0	68	15
ANIMALS.											
Rhizopoda, Difflugia,	0	0	0	0	0	0	0	0	0	0	2
Infusoria,	1	3	10	1	1,462	160	51	0	8	370	202
Dinobryon,	1	0	8	1	1,460	160	51	0	6	360	200
Miscellaneous, Zoöglœa,	10	5	20	0	0	15	5	2	10	5	0
TOTAL,	39	8	68	125	1,831	233	83	21	46	721	299

Chemical Examination of Water from Loon Pond, Springfield.

[Parts per 100,000.]

Number.	Date of Collection.	Appearance. Turbidity.	Appearance. Sediment.	Appearance. Color.	Residue on Evaporation. Total.	Residue on Evaporation. Loss on Ignition.	Ammonia. Free.	Ammonia. Albuminoid. Total.	Ammonia. Albuminoid. Dissolved.	Ammonia. Albuminoid. Suspended.	Chlorine.	Nitrogen as Nitrates.	Nitrogen as Nitrites.	Oxygen Consumed.	Hardness.
	1897.														
18370	Jan. 26	V. slight.	V. slight.	.02	2.75	1.10	.0006	.0198	.0192	.0006	.23	.0030	.0000	.19	0.6
18454	Feb. 8	V. slight.	Slight.	.03	2.35	0.75	.0006	.0168	.0168	.0000	.22	.0030	.0000	.16	0.6
19008	Apr. 12	V. slight.	Slight.	.05	2.05	0.70	.0018	.0202	.0188	.0014	.22	.0000	.0000	.22	0.3
19185	May 5	V. slight.	Slight.	.00	2.05	0.45	.0018	.0158	.0142	.0016	.21	.0000	.0000	.14	0.6
19403	June 7	V. slight.	V. slight.	.05	2.35	1.10	.0004	.0188	.0174	.0014	.20	.0030	.0000	.14	0.6
19752	July 8	Slight.	V. slight.	.03	2.65	1.00	.0004	.0204	.0156	.0048	.15	.0000	.0000	.20	0.6
20032	Aug. 9	Distinct.	Cons.	.05	2.50	1.05	.0006	.0250	.0156	.0094	.20	.0000	.0000	.18	0.5
20403	Sept. 8	V. slight.	V. slight.	.05	2.65	1.05	.0010	.0210	.0174	.0036	.22	.0020	.0000	.18	1.0
20739	Oct. 6	V. slight.	V. slight.	.08	2.60	1.15	.0008	.0232	.0216	.0016	.20	.0020	.0000	.17	1.1
21071	Nov. 8	V. slight.	Slight.	.08	2.75	1.40	.0008	.0194	.0186	.0008	.23	.0020	.0000	.22	1.0
Av...	1897	....	....	.04	2.47	0.97	.0009	.0200	.0175	.0025	.21	.0015	.0000	.18	0.7
Av...	1896*	....	....	.04	2.65	1.15	.0007	.0202	.0172	.0030	.23	.0017	.0000	.19	0.8

* July to December.

NOTE to analyses of 1897: Odor, generally faintly vegetable.—— The samples were collected from the pond, near the surface. This pond is not used as a source of public water supply.

SPRINGFIELD.

Microscopical Examination of Water from Loon Pond, Springfield.

[Number of organisms per cubic centimeter.]

	1897.									
	Jan.	Feb.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.
Day of examination,	30	10	14	8	8	10	11	9	8	9
Number of sample,	18370	18454	19008	19185	19403	19752	20032	20403	20739	21071
PLANTS.										
Diatomaceæ,	0	1	8	1	2	0	0	8	8	11
Cyanophyceæ,	0	0	0	0	5	185	293	4	0	0
Anabæna,	0	0	0	0	5	2	293	0	0	0
Chroöcoccus,	0	0	0	0	0	176	0	0	0	0
Algæ,	0	0	0	0	97	0	37	3	15	0
Staurogenia,	0	0	0	0	80	0	30	0	5	0
ANIMALS.										
Rhizopoda, Actinophrys,	0	0	0	0	1	0	0	0	0	1
Infusoria,	1	0	1	0	16	0	1	2	3	3
Dinobryon,	0	0	0	0	15	0	0	0	1	3
Vermes, Asplanchna,	0	0	1	0	0	0	0	0	0	0
Crustacea, Cyclops,	0	0	pr.	pr.	0	0	0	0	0	0
Miscellaneous, Zoöglœa,	40	0	5	0	5	5	10	3	25	0
TOTAL,	41	1	15	1	126	190	341	20	51	15

Chemical Examination of Water from Five Mile Pond, Springfield.

[Parts per 100,000.]

Number.	Date of Collection.	Appearance.			Residue on Evaporation.		Ammonia.				Chlorine.	Nitrogen as		Oxygen Consumed.	Hardness.
								Albuminoid.							
		Turbidity.	Sediment.	Color.	Total.	Loss on Ignition.	Free.	Total.	Dissolved.	Suspended.		Nitrates.	Nitrites.		
	1897.														
18368	Jan. 26	V. slight.	V. slight.	.05	2.05	1.10	.0014	.0244	.0212	.0032	.16	.0030	.0000	.33	0.3
18452	Feb. 8	V. slight.	Slight.	.03	0.75	0.15	.0046	.0078	.0066	.0012	.07	.0030	.0000	.11	0.0
18744	Mar. 9	V. slight.	Slight.	.05	2.15	0.65	.0036	.0186	.0176	.0010	.17	.0030	.0000	.18	0.0
19007	Apr. 12	V. slight.	V. slight.	.07	1.80	0.90	.0012	.0200	.0184	.0016	.18	.0000	.0000	.23	0.3
19183	May 5	V. slight.	V. slight.	.05	1.95	0.75	.0012	.0200	.0188	.0012	.14	.0000	.0000	.22	0.3
19402	June 7	V. slight.	V. slight.	–	3.35	2.25	.0012	.0528	.0482	.0046	.10	.0030	.0000	.89	0.2
19751	July 8	V. slight.	V. slight.	.04	1.65	1.00	.0004	.0206	.0166	.0040	.16	.0000	.0000	.29	0.3
20030	Aug. 9	V. slight.	V. slight.	.12	1.80	1.05	.0006	.0202	.0188	.0014	.11	.0020	.0000	.31	0.3
20402	Sept. 8	V. slight.	V. slight.	.12	2.10	1.10	.0002	.0234	.0192	.0042	.16	.0000	.0000	.28	0.3
20737	Oct. 6	V. slight.	V. slight.	.13	2.30	1.15	.0006	.0254	.0208	.0046	.13	.0020	.0000	.29	0.6
21072	Nov. 8	V. slight.	Slight.	.18	2.35	1.30	.0020	.0200	.0198	.0002	.17	.0020	.0000	.28	0.8
21485	Dec. 8	V. slight.	V. slight.	.16	2.40	1.15	.0026	.0222	.0222	.0000	.18	.0020	.0001	.27	1.0
Av...	1897	....	....	.09	2.05	1.05	.0016	.0230	.0207	.0023	.14	.0017	.0000	.31	0.4
Av...	1896*	....	....	.07	2.23	1.06	.0009	.0214	.0193	.0021	.15	.0009	.0000	.22	0.4

* June to December.

NOTE to analyses of 1897: Odor, vegetable. In October the odor became distinctly fishy on heating. —— The samples were collected from the pond, near the surface. This pond is not used as a source of public water supply.

SPRINGFIELD.

Table showing Heights of Water in Ludlow Reservoir on the First of Each Month in 1897.

NOTE. — Height of rollway, 28.1 feet above bottom of reservoir.

Date.	Height of Water above Bottom of Reservoir.	Date.	Height of Water above Bottom of Reservoir.
1897.	Feet.	1897.	Feet.
Jan. 1,	12.94	July 1,	17.25
Feb. 1,	13.83	Aug. 1,	17.66
March 1,	15.65	Sept. 1,	16.60
April 1,	18.10	Oct. 1,	15.24
May 1,	18.00	Nov. 1,	13.90
June 1,	18.25	Dec. 1,	14.40

WATER SUPPLY OF STOCKBRIDGE. — STOCKBRIDGE WATER COMPANY.

Chemical Examination of Water from Lake Averic, Stockbridge.

[Parts per 100,000.]

Number.	Date of Collection.	Appearance.			Residue on Evaporation.		Ammonia.				Chlorine.	Nitrogen as		Oxygen Consumed.	Hardness.
		Turbidity.	Sediment.	Color.	Total.	Loss on Ignition.	Free.	Albuminoid. Total.	Albuminoid. Dissolved.	Albuminoid. Suspended.		Nitrates.	Nitrites.		
	1897.														
18364	Jan. 26	V. slight.	V. slight.	.20	6.60	1.45	.0014	.0172	.0152	.0020	.08	.0050	.0000	.25	4.2
18620	Feb. 23	Slight.	Slight.	.32	6.50	2.30	.0012	.0476	.0306	.0170	.10	.0030	.0000	.40	3.9
18971	Apr. 6	V. slight.	V. slight.	.06	4.10	0.90	.0000	.0178	.0122	.0056	.05	.0050	.0000	.05	2.9
19202	May 10	V. slight.	Slight.	.15	5.65	1.20	.0002	.0124	.0112	.0012	.09	.0130	.0000	.21	4.0
19551	June 22	None.	V. slight.	.11	6.00	1.55	.0000	.0106	.0094	.0012	.05	.0080	.0000	.27	4.2
19933	July 27	V. slight.	V. slight.	.17	5.75	1.25	.0000	.0194	.0166	.0028	.06	.0000	.0000	.38	3.9
20036	Aug. 9	V. slight.	V. slight.	.18	6.60	1.20	.0014	.0158	.0134	.0024	.04	.0000	.0000	.35	4.4
20664	Sept. 28	V. slight.	V. slight.	.18	6.40	–	.0020	.0184	.0130	.0054	.10	.0000	.0000	.34	5.0
20988	Oct. 27	None.	V. slight.	.13	6.85	1.25	.0022	.0190	.0182	.0008	.06	.0000	.0000	.29	5.5
21368	Nov. 24	None.	Slight.	.20	6.70	1.70	.0020	.0200	.0176	.0024	.11	.0030	.0000	.31	4.9
21681	Dec. 28	Slight.	V. slight.	.13	6.25	1.50	.0034	.0138	.0122	.0016	.09	.0060	.0000	.26	4.3

Averages by Years.

–	1893	–	–	.06	6.15	1.45	.0092	.0165	.0137	.0028	.07	.0067	.0020	.26	4.1
–	1896	–	–	.14	6.46	1.43	.0006	.0196	.0160	.0036	.09	.0036	.0001	.29	4.8
–	1897	–	–	.17	6.10*	1.43	.0013	.0193	.0154	.0039	.08	.0039	.0000	.28	4.3

* Exclusive of No. 20664.

NOTE to analyses of 1897: Odor of the second sample, decidedly fishy and oily; of the others, faintly vegetable, becoming sometimes stronger on heating. —— No. 19551 was collected from a faucet in the village, and the other samples from the lake.

STOCKBRIDGE.

Microscopical Examination of Water from Lake Averic, Stockbridge.

[Number of organisms per cubic centimeter.]

	1897.										
	Jan.	Feb.	Apr.	May.	June.	July.	Aug.	Oct.	Oct.	Nov	Dec.
Date of examination,	30	25	8	11	24	29	11	4	28	29	29
Number of sample,	18364	18620	18971	19202	19551	19933	20036	20664	20988	21368	21681
PLANTS.											
Diatomaceæ,	0	0	3	59	5	64	5	249	20	18	18
Fragilaria,	0	0	0	0	0	0	0	212	0	0	0
Synedra,	0	0	1	17	1	64	5	7	0	2	5
Cyanophyceæ, Anabæna,	0	0	0	0	0	14	2	0	0	0	0
Algæ,	0	5	0	2	2	4	14	0	0	0	2
ANIMALS.											
Rhizopoda, Actinophrys,	0	0	0	0	0	0	0	2	0	0	0
Infusoria,	17	33	579	7	0	49	9	6	214	26	21
Dinobryon,	1	1	576	4	0	0	0	0	210	17	19
Peridinium,	0	1	3	2	0	36	5	0	0	3	0
Trachelomonas,	0	0	0	1	0	10	3	6	3	1	0
Uroglena,	15	30	0	0	0	0	0	0	0	0	0
Vermes,	0	0	0	0	1	3	0	4	0	1	1
Crustacea,	0	0	0	0	0	0	0	pr.	pr.	0	0
Miscellaneous, Zoöglœa,	0	0	0	0	0	100	8	30	pr.	0	0
TOTAL,	17	38	582	68	8	234	38	291	234	45	42

STOCKBRIDGE.

Chemical Examination of Water from Reservoir of the Stockbridge Water Company.

[Parts per 100,000.]

Number.	Date of Collection.	Appearance.			Residue on Evaporation.		Ammonia.				Chlorine.	Nitrogen as		Oxygen Consumed.	Hardness.
		Turbidity.	Sediment.	Color.	Total.	Loss on Ignition.	Free.	Albuminoid. Total.	Albuminoid. Dissolved.	Albuminoid. Suspended.		Nitrates.	Nitrites.		
	1897.														
18825	Mar. 22	V. slight.	Slight.	.02	8.65	-	.0006	.0068	.0046	.0022	.11	.0020	.0000	.08	7.4
18972	Apr. 6	V. slight.	Slight.	.03	7.55	0.85	.0006	.0062	.0056	.0006	.11	.0020	.0000	.09	5.7
19203	May 10	None.	Slight.	.02	9.20	1.10	.0000	.0022	.0018	.0004	.10	.0180	.0002	.03	7.3
19554	June 22	None.	Slight.	.00	9.50	1.40	.0008	.0034	.0030	.0004	.06	.0020	.0000	.04	7.4
19935	July 27	None.	V. slight.	.02	9.70	1.80	.0000	.0030	.0018	.0012	.11	.0000	.0000	.08	7.6
20037	Aug. 9	V. slight.	V. slight.	.02	9.90	1.20	.0002	.0028	.0020	.0008	.09	.0020	.0000	.08	8.0
20665	Sept. 28	None.	V. slight.	.02	11.95	-	.0002	.0020	.0014	.0006	.10	.0000	.0000	.05	10.1
20987	Oct. 27	None.	None.	.07	11.00	0.65	.0008	.0072	.0072	.0000	.13	.0030	.0000	.08	8.0
21370	Nov. 24	None.	V. slight.	.05	11.95	1.45	.0006	.0028	.0028	.0000	.12	.0000	.0000	.06	10.3
21683	Dec. 28	V. slight.	Slight.	.11	8.10	1.15	.0022	.0030	.0030	.0000	.14	.0010	.0000	.04	6.6
Av...	....	....	....	.04	*9.61	1.20	.0006	.0039	.0033	.0006	.11	.0030	.0000	.06	7.8

* Exclusive of Nos. 18825 and 20665.

Odor, generally none, occasionally faintly vegetable. —— The samples were collected from the reservoir on Bear Mountain.

Swampscott.

The advice of the State Board of Health to the town of Swampscott, relative to certain plans for supplying the town with water, may be found on pages 42 to 45 of this volume. The sources of supply under consideration were those controlled and operated by the Marblehead Water Company in Swampscott, the town of Marblehead, the city of Lynn and the Metropolitan Water Board. The results of the analyses of samples of water from the first three sources may be found under Swampscott, Marblehead and Lynn, respectively.

SWAMPSCOTT.

WATER SUPPLY OF SWAMPSCOTT AND NAHANT. — MARBLEHEAD WATER COMPANY.

Chemical Examination of Water from the Wells of the Marblehead Water Company, Swampscott.

[Parts per 100,000.]

Number	Date of Collection.	Appearance. Turbidity.	Appearance. Sediment.	Appearance. Color.	Residue on Evaporation.	Ammonia. Free.	Ammonia. Albu-minoid.	Chlorine.	Nitrogen as Nitrates.	Nitrogen as Nitrites.	Oxygen Consumed.	Hardness.	Iron.
	1897.												
18256	Jan. 13	Slight.	V. slight.	.05	52.90	.0002	.0026	14.40	.2500	.0001	.01	11.2	.0400
18685	Mar. 2	None.	None.	.02	19.20	.0006	.0036	3.90	.1050	.0000	.06	6.7	.0020
18983	Apr. 8	None.	None.	.08	12.30	.0004	.0016	1.57	.0300	.0000	.02	7.3	.0090
19170	May 5	None.	None.	.00	12.20	.0000	.0018	1.25	.0280	.0000	.03	7.4	.0000
19358	June 1	-	-	-	-	.0004	.0010	-	-	-	-	7.9	-
19382	June 2	V. slight.	Cons.	.00	14.50	.0006	.0008	1.34	.0700	.0000	.03	7.3	.0030
19738	July 7	None.	None.	.00	65.60	.0000	.0026	20.00	.2100	.0002	.01	13.6	.0000
19824	July 19	None.	None.	.00	82.60	.0004	.0014	27.65	.1900	.0002	.06	32.0	.0000
19985	Aug. 3	None.	None.	.00	65.10	.0012	.0016	20.90	.2400	.0000	.05	23.5	.0000
20371	Sept. 6	None.	None.	.00	20.90	.0000	.0010	3.54	.1200	.0001	.08	9.4	.0020
20720	Oct. 5	None.	None.	.00	17.50	.0002	.0010	2.66	.1100	.0001	.00	8.3	.0020
21049	Nov. 3	V. slight.	None.	.04	15.90	.0006	.0024	2.36	.1060	.0000	.02	9.0	.0030
21454	Dec. 6	None.	V. slight.	.05	15.70	.0006	.0034	2.20	.0590	.0000	.02	8.9	.0010

Averages by Years.

-	1888	-	-	.00	25.16	.0007	.0035	3.26	.4477	.0003	-	-	-
-	1891	-	-	.00	38.64	.0018	.0010	7.73	.9909	.0002	-	18.0	-
-	1892	-	-	.00	54.94	.0000	.0010	14.53	.7437	.0000	-	22.0	.0074
-	1893	-	-	.01	46.42	.0000	.0022	12.12	.4263	.0000	.07	14.7	.0061
-	1894	-	-	.04	37.84	.0002	.0018	10.52	.2983	.0000	.05	15.8	.0066
-	1895	-	-	.08	29.51	.0002	.0033	6.91	.1148	.0000	.10	9.4	.0072
-	1896	-	-	.02	58.86	.0006	.0028	18.53	.1275	.0001	.07	25.2	.0047
-	1897*	-	-	.02	29.12	.0004	.0020	3.54	.1198	.0000	.03	11.1	.0056

* Where more than one sample was collected in a month, the mean analysis for that month has been used in making the average.

NOTE to analyses of 1897: Odor, none.—— Nos. 18685, 19170, 19824, 19985 and 21454 were collected from a faucet in the town; the others from a faucet at the pumping station.

SWAMPSCOTT.

Chemical Examination of Water from the Main Brook flowing through Thompson Meadow, Swampscott.

[Parts per 100,000.]

Number.	Date of Collection.	Appearance.			Residue on Evaporation.		Ammonia.				Chlorine.	Nitrogen as		Oxygen Consumed.	Hardness.
								Albuminoid.							
		Turbidity.	Sediment.	Color.	Total.	Loss on Ignition.	Free.	Total.	Dissolved.	Sus-pended.		Nitrates.	Nitrites.		
	1897.														
18802	Mar. 16	V. slight.	Cons.	0.60	6.10	2.25	.0338	.0226	.0214	.0012	0.81	.0280	.0004	0.51	2.1
19361	June 1	–	–	–	–	–	.0606	.0392	–	–	–	–	–	–	3.0
19736	July 7	V. slight.	Slight.	1.25	8.30	3.20	.0040	.0346	.0322	.0024	0.89	.0250	.0001	1.11	3.4
19825	July 19	V. slight.	V. slight.	1.05	9.35	3.25	.0018	.0352	.0312	.0040	1.22	.0050	.0001	0.91	3.5
19982	Aug. 3	V. slight.	Slight.	1.12	11.15	4.15	.1320	.0500	.0480	.0020	1.00	.0280	.0115	1.33	3.8
20369	Sept. 6	V. slight.	Cons.	0.68	9.85	3.20	.0008	.0304	.0286	.0018	0.97	.0350	.0003	0.92	3.6
20718	Oct. 5	V. slight.	Cons.	0.42	8.80	2.55	.0018	.0192	.0160	.0032	0.96	.0120	.0003	0.39	3.6
21047	Nov. 4	Slight.	Cons.	1.90	16.25	6.15	.3920	.0980	.0790	.0190	1.56	.0390	.0025	1.75	5.9
21452	Dec. 6	V. slight.	Cons.	0.91	10.50	2.90	.1210	.0376	.0360	.0016	0.98	.0830	.0019	0.82	3.9
Av.*	....	....	....	0.97	10.21	3.49	.0931	.0418†	.0372	.0046	1.05	.0343	.0024	0.96	3.7

* Where more than one sample was collected in a month, the mean analysis for that month has been used in making the average.

† Exclusive of No. 19361.

Odor, generally faintly vegetable, becoming stronger on heating.—— The samples were collected from the brook, at head of Thompson Meadow.

Chemical Examination of Water from a Brook which flows near the Tubular Wells in Thompson Meadow, Swampscott.

[Parts per 100,000.]

Number.	Date of Collection.	Appearance.			Residue on Evaporation.		Ammonia.				Chlorine.	Nitrogen as		Oxygen Consumed.	Hardness.
								Albuminoid.							
		Turbidity.	Sediment.	Color.	Total.	Loss on Ignition.	Free.	Total.	Dissolved.	Sus-pended.		Nitrates.	Nitrites.		
	1897.														
18801	Mar. 16	V. slight.	Cons.	0.35	6.10	2.10	.0018	.0088	.0078	.0010	1.02	.0280	.0000	.34	2.3
19360	June 1	–	–	–	–	–	.0032	.0132	–	–	–	–	–	–	2.7

Odor of the first sample, distinctly vegetable; the odor was not determined in the other sample.

SWAMPSCOTT.

Chemical Examination of Water from Tubular Wells at the Southerly End of Thompson Meadow in Swampscott and Salem.

[Parts per 100,000.]

Number.	Date of Collection.	Appearance.			Residue on Evaporation.	Ammonia.		Chlorine.	Nitrogen as		Oxygen Consumed.	Hardness.	Iron.
		Turbidity.	Sediment.	Color.		Free.	Albuminoid.		Nitrates.	Nitrites.			
	1897.												
18425	Feb. 2	None.	None.	.00	9.70	.0000	.0010	1.05	.0250	.0000	.02	4.7	.0000
18984	Apr. 8	None.	None.	.00	11.40	.0002	.0018	1.17	.0250	.0004	.02	7.1	.0000
19169	May 4	None.	None.	.00	12.30	.0006	.0008	1.55	.0270	.0003	.04	7.4	.0000
19381	June 2	None.	None.	.00	12.70	.0000	.0010	1.00	.0350	.0001	.02	7.1	.0030
19737	July 7	None.	None.	.00	13.50	.0000	.0016	1.20	.0300	.0005	.01	7.4	.0000
19822	July 19	None.	None.	.00	13.50	.0004	.0024	1.40	.0300	.0001	.01	8.0	.0000
19983	Aug. 3	None.	None.	.00	13.70	.0002	.0030	1.40	.0320	.0003	.03	8.5	.0000
20370	Sept. 6	None.	None.	.00	14.70	.0000	.0016	1.31	.0300	.0002	.12	8.4	.0250
20721	Oct. 5	V. slight, milky.	None.	.05	16.40	.0018	.0038	1.36	.0450	.0007	.08	9.4	.0040
21048	Nov. 4	None.	None.	.05	16.90	.0006	.0042	1.46	.0360	.0010	.06	9.7	.0030
21453	Dec. 6	None.	None.	.05	11.70	.0008	.0046	1.31	.0320	.0001	.02	7.1	.0000
Av.*.	....	....	....	.01	13.30	.0004	.0024	1.29	.0317	.0003	.04	7.7	.0035

* Where more than one sample was collected in a month, the mean analysis for that month has been used in making the average.

Odor, none.—— The samples were collected from a faucet at the pumping station in Thompson Meadow.

Chemical Examination of Water from a System of Tubular Wells a Short Distance East of the Swampscott Station on the Boston & Maine Railroad.

[Parts per 100,000.]

Number.	Date of Collection.	Appearance.			Residue on Evaporation.	Ammonia.		Chlorine.	Nitrogen as		Oxygen Consumed.	Hardness.	Iron.
		Turbidity.	Sediment.	Color.		Free.	Albuminoid.		Nitrates.	Nitrites.			
	1897.												
19359	June 1	-	-	-	-	.0002	.0004	-	-	-	-	9.0	-
19739	July 7	None.	V. slight.	.00	14.30	.0000	.0018	1.98	.0650	.0000	.01	7.7	.0000
19823	July 19	None.	None.	.00	14.70	.0004	.0020	1.90	.0480	.0002	.00	8.0	.0000
19984	Aug. 3	None.	None.	.00	14.40	.0006	.0018	2.00	.0680	.0004	.02	8.0	.0000
20372	Sept. 6	None.	None.	.00	14.90	.0000	.0024	1.85	.0530	.0007	-	7.9	-
20719	Oct. 5	None.	None.	.00	14.10	.0000	.0008	1.80	.0600	.0005	.03	7.6	.0020
21050	Nov. 4	None.	None.	.01	14.40	.0008	.0022	2.02	.0440	.0020	.02	8.1	.0040
21455	Dec. 6	None.	V. slight.	.05	14.50	.0006	.0026	1.94	.0430	.0008	.01	8.3	.0010
Av.*.	....	....	....	.01	14.47	.0003	.0017	1.92	.0541	.0007	.01	8.1	.0012

* Where more than one sample was collected in a month, the mean analysis for that month has been used in making the average.

Odor, none.—— The samples were collected from a faucet at the pumping station.

WATER SUPPLY OF TAUNTON.

Chemical Examination of Water from Assawompsett Pond, Lakeville.

[Parts per 100,000.]

Number.	Date of Collection.	Appearance.			Residue on Evaporation.		Ammonia.				Chlorine.	Nitrogen as		Oxygen Consumed.	Hardness.
								Albuminoid.							
		Turbidity.	Sediment.	Color.	Total.	Loss on Ignition.	Free.	Total.	Dissolved.	Sus-pended.		Nitrates.	Nitrites.		
	1897.														
18356	Jan. 25	Slight.	V. slight.	.43	4.50	2.30	.0010	.0210	.0200	.0010	.58	.0030	.0000	.61	0.8
18589	Feb. 22	V. slight.	V. slight.	.60	3.65	1.95	.0004	.0198	.0172	.0026	.60	.0000	.0000	.62	1.2
18869	Mar. 24	V. slight.	Slight.	.45	3.95	2.15	.0020	.0220	.0156	.0064	.56	.0000	.0000	.57	0.6
19141	Apr. 28	V. slight.	Slight.	.50	3.35	1.50	.0012	.0264	.0224	.0040	.56	.0000	.0001	.61	0.6
19338	May 27	V. slight.	Slight.	.32	3.40	1.30	.0010	.0268	.0204	.0064	.56	.0030	.0000	.63	1.1
19539	June 21	V. slight.	Slight.	.42	3.35	1.50	.0020	.0188	.0144	.0044	.49	.0000	.0000	.60	0.6
19918	July 26	V. slight.	V. slight.	.32	3.25	1.15	.0012	.0190	.0170	.0020	.60	.0100	.0000	.53	0.6
20253	Aug. 23	V. slight.	V. slight.	.28	3.45	1.35	.0008	.0174	.0168	.0006	.56	.0020	.0000	.44	0.8
20654	Sept. 27	V. slight.	V slight.	.22	3.15	1.45	.0000	.0178	.0164	.0014	.52	.0000	.0000	.39	0.9
20963	Oct. 25	V. slight.	V. slight.	.23	3.65	1.50	.0004	.0178	.0146	.0032	.60	.0080	.0000	.40	1.8
21323	Nov. 22	V. slight.	V. slight.	.21	3.30	1.45	.0018	.0216	.0208	.0008	.61	.0020	.0000	.38	1.0
21721	Dec. 30	V. slight.	V. slight.	.30	3.35	1.25	.0010	.0184	.0170	.0014	.66	.0050	.0000	.48	1.1

Averages by Years.

-	1894	-	-	.33	3.22	1.26	.0003	.0157	.0132	.0025	.51	.0021	.0000	.43	0.7
-	1895	-	-	.36	3.34	1.54	.0005	.0185	.0157	.0028	.53	.0013	.0000	.50	0.7
-	1896	-	-	.33	3.58	1.47	.0008	.0179	.0160	.0019	.54	.0032	.0000	.52	0.9
-	1897	-	-	.36	3.56	1.57	.0011	.0206	.0177	.0029	.57	.0027	.0000	.52	0.9

NOTE to analyses of 1897: Odor, generally vegetable; in February, March and April, fishy and oily. —— The samples were collected from the pond, at the intake of the Taunton Water Works.

Microscopical Examination of Water from Assawompsett Pond, Lakeville.

[Number of organisms per cubic centimeter.]

	1897.											1898.
	Jan.	Feb.	Mar.	Apr.	June.	June.	July.	Aug.	Oct.	Oct.	Nov.	Jan.
Day of examination, . . .	29	24	27	30	1	23	28	24	4	27	23	3
Number of sample, . . .	18356	18589	18869	19141	19338	19539	19918	20253	20654	20963	21323	21721
PLANTS.												
Diatomaceæ, ...	40	21	112	20	211	232	251	63	82	13	36	44
Asterionella, ...	0	17	104	0	11	66	0	8	0	6	4	15
Fragilaria, ...	0	0	0	0	0	8	84	0	0	0	0	5
Melosira, ...	0	0	5	16	156	132	152	54	60	0	5	0
Cyanophyceæ, Anabæna, .	0	0	0	0	208	4	0	0	0	0	0	0
Algæ, Protococcus, . . .	0	0	0	5	2	8	0	0	6	1	0	0

TAUNTON.

Microscopical Examination of Water from Assawompsett Pond, Lakeville — Concluded.

[Number of organisms per cubic centimeter.]

	1897.											1898.
	Jan.	Feb.	Mar.	Apr.	June	June.	July.	Aug.	Oct.	Oct.	Nov.	Jan.
ANIMALS.												
Rhizopoda,	0	0	4	0	0	0	0	0	0	1	0	0
Infusoria,	7	106	510	84	2	0	8	17	0	1	15	27
Dinobryon,	5	97	496	72	0	0	0	16	0	0	15	27
Uroglena,	0	8	12	12	0	0	0	0	0	0	0	0
Vermes, Anurea,	0	0	0	0	0	0	0	1	1	0	0	0
Crustacea, Cyclops,	0	0	0	0	0	0	pr.	0	0	0	pr.	0
Miscellaneous, Zoöglœa,	0	5	40	60	40	50	120	10	10	3	5	0
TOTAL,	47	132	666	169	463	294	379	91	99	19	56	71

Chemical Examination of Water from Elder's Pond, Lakeville.

[Parts per 100,000.]

Number.	Date of Collection.	Appearance.			Residue on Evaporation.		Ammonia.				Chlorine.	Nitrogen as		Oxygen Consumed.	Hardness.
								Albuminoid.							
		Turbidity.	Sediment.	Color.	Total.	Loss on Ignition.	Free.	Total.	Dissolved.	Sus-pended.		Nitrates.	Nitrites.		
	1897.														
18357	Jan. 25	V. slight.	V. slight.	.02	1.95	1.05	.0012	.0086	.0076	.0010	.36	.0000	.0000	.11	0.2
18588	Feb. 22	V. slight.	V. slight.	.03	2.35	1.35	.0008	.0166	.0150	.0016	.53	.0000	.0000	.21	0.5
18870	Mar. 24	V. slight.	V. slight.	.10	2.70	1.35	.0008	.0148	.0142	.0006	.51	.0000	.0000	.18	0.5
19140	Apr. 28	V. slight.	V. slight.	.05	2.35	0.80	.0012	.0148	.0122	.0026	.51	.0000	.0060	.22	0.5
19339	May 27	V. slight.	Slight.	.10	2.65	0.75	.0010	.0194	.0178	.0016	.50	.0030	.0000	.39	0.9
19540	June 21	V. slight.	V. slight.	.04	2.60	1.35	.0004	.0148	.0134	.0014	.51	.0020	.0000	.18	0.5
19919	July 26	V. slight.	V. slight.	.07	2.65	0.80	.0018	.0144	.0134	.0010	.59	.0100	.0000	.26	0.5
20254	Aug. 23	V. slight.	V. slight.	.04	2.90	1.10	.0006	.0150	.0126	.0024	.53	.0020	.0000	.19	0.6
20655	Sept. 27	Slight.	V. slight.	.10	2.80	1.30	.0008	.0160	.0142	.0018	.55	.0000	.0000	.25	0.4
20964	Oct. 25	V. slight.	V. slight.	.07	3.20	1.10	.0012	.0160	.0156	.0004	.57	.0150	.0000	.35	1.9
21322	Nov. 22	None.	V. slight.	.10	2.80	1.05	.0046	.0198	.0198	.0000	.57	.0030	.0000	.22	0.5
21722	Dec. 30	V. slight.	Slight.	.05	2.40	1.05	.0012	.0152	.0150	.0002	.61	.0040	.0000	.18	0.8

Averages by Years.

–	1894	–	–	.04	2.32	0.94	.0004	.0135	.0120	.0015	.42	.0015	.0000	.17	0.4
–	1895	–	–	.05	2.57	0.98	.0001	.0161	.0143	.0018	.46	.0018	.0000	.22	0.5
–	1896	–	–	.05	2.70	0.96	.0005	.0169	.0139	.0030	.50	.0017	.0000	.22	0.5
–	1897	–	–	.06	2.61	1.09	.0013	.0154	.0142	.0012	.53	.0032	.0000	.23	0.6

NOTE to analyses of 1897: Odor, vegetable. —— The samples were collected from the pond, near the gate-house of the Taunton Water Works.

Water Supply of Tisbury. — Vineyard Haven Water Company.

Chemical Examination of Water from the Filter-gallery at Tashmoo Spring.

[Parts per 100,000.]

Number.	Date of Collection.	Appearance.			Residue on Evaporation.	Ammonia.		Chlorine.	Nitrogen as		Oxygen Consumed.	Hardness.	Iron.
		Turbidity.	Sediment.	Color.		Free.	Albuminoid.		Nitrates.	Nitrites.			
19910	1897. July 26	None.	None.	.00	4.50	.0004	.0008	.99	.0100	.0000	.00	0.6	.0000

Odor, none. —— The sample was collected from a faucet at the pumping station, while pumping.

Water Supply of Uxbridge.

Chemical Examination of Water from a Faucet in Uxbridge supplied from the Uxbridge Water Works.

[Parts per 100,000.]

Number.	Date of Collection.	Appearance.			Residue on Evaporation.	Ammonia.		Chlorine.	Nitrogen as		Oxygen Consumed.	Hardness.	Iron.
		Turbidity.	Sediment.	Color.		Free.	Albuminoid.		Nitrates.	Nitrites.			
20251	1897. Aug. 23	None.	None.	.00	2.70	.0016	.0010	.17	.0020	.0000	.00	0.6	.0000

Odor, none. —— The sample was collected from a faucet in the town.

Water Supply of Wakefield and Stoneham. — Wakefield Water Company.

Chemical Examination of Water from Crystal Lake, Wakefield.

[Parts per 100,000.]

Number.	Date of Collection.	Appearance.			Residue on Evaporation.		Ammonia.				Chlorine.	Nitrogen as		Oxygen Consumed.	Hardness.
								Albuminoid.							
		Turbidity.	Sediment.	Color.	Total.	Loss on Ignition.	Free.	Total.	Dissolved.	Suspended.		Nitrates.	Nitrites.		
	1897.														
18702	Mar. 3	V. slight.	Slight.	.08	4.65	1.40	.0020	.0118	.0108	.0010	.72	.0230	.0005	.32	0.8
19373	June 2	V. slight.	V. slight.	.23	4.45	1.40	.0014	.0160	.0148	.0012	.63	.0080	.0001	.27	2.1
20395	Sept. 8	V. slight.	Slight.	.15	5.25	1.15	.0000	.0126	.0126	.0000	.67	.0030	.0000	.28	2.2
21482	Dec. 8	V. slight.	V. slight.	.20	4.55	1.40	.0028	.0202	.0180	.0022	.72	.0080	.0002	.29	2.1

WAKEFIELD.

Chemical Examination of Water from Crystal Lake, Wakefield — Concluded.

Averages by Years.

[Parts per 100,000.]

Number.	Date of Collection.	Appearance.			Residue on Evaporation.		Ammonia.				Chlorine.	Nitrogen as		Oxygen Consumed.	Hardness.
		Turbidity.	Sediment.	Color.	Total.	Loss on Ignition.	Free.	Albuminoid. Total.	Albuminoid. Dissolved.	Albuminoid. Sus-pended.		Nitrates.	Nitrites.		
-	1893	-	-	.14	3.81	1.27	.0028	.0164	.0141	.0023	.57	.0108	.0001	.26	1.5
-	1894	-	-	.16	4.39	1.26	.0011	.0155	.0136	.0019	.67	.0105	.0001	.24	1.8
-	1895	-	-	.18	4.46	1.50	.0023	.0166	.0140	.0026	.71	.0087	.0000	.32	1.7
-	1896	-	-	.19	4.56	1.34	.0021	.0175	.0148	.0027	.71	.0130	.0000	.26	2.0
-	1897	-	-	.16	4.72	1.34	.0015	.0151	.0140	.0011	.68	.0105	.0002	.29	1.8

NOTE to analyses of 1897: Odor, faintly vegetable. —— The samples were collected from a faucet at the pumping station.

WATER SUPPLY OF WALPOLE.

Chemical Examination of Water from the Wells of the Walpole Water Works.

[Parts per 100,000.]

Number.	Date of Collection.	Appearance.			Residue on Evaporation.	Ammonia.		Chlorine.	Nitrogen as		Oxygen Consumed.	Hardness.	Iron.
		Turbidity.	Sediment.	Color.		Free.	Albu-minoid.		Nitrates.	Nitrites.			
	1897.												
18421	Feb. 2	None.	None.	.00	2.80	.0000	.0000	.26	.0050	.0000	.00	0.6	.0000
19067	Apr. 19	None.	None.	.00	3.00	.0004	.0006	.27	.0050	.0000	.02	1.4	.0000
19591	June 28	None.	None.	.00	3.00	.0000	.0020	.29	.0070	.0000	.05	0.9	.0000
20329	Aug. 31	None.	V. slight.	.00	4.10	.0008	.0012	.28	.0030	.0000	.01	1.1	.0020
20976	Oct. 27	None.	None.	.02	3.60	.0004	.0006	.30	.0150	.0000	.01	1.3	.0100
21692	Dec. 29	V. slight.	V. slight.	.02	4.60	.0000	.0016	.30	.0070	.0000	.00	1.4	.0020
Av...	....	....	....	.01	3.52	.0003	.0010	.28	.0070	.0000	.01	1.1	.0023

Odor, none. —— Nos. 18421 and 19067 were collected from one of the tubular wells at the pumping station; the remaining samples, from a faucet at the pumping station.

Water Supply of Waltham.

The advice of the State Board of Health to the city of Waltham, in regard to the quality of the water supply of the city, may be found on pages 45 to 47 of this volume.

Chemical Examination of Water from the Well and Filter-gallery of the Waltham Water Works.

[Parts per 100,000.]

Number.	Date of Collection.	Appearance.			Residue on Evaporation.	Ammonia.		Chlorine.	Nitrogen as		Oxygen Consumed.	Hardness.	Iron.
		Turbidity.	Sediment.	Color.		Free.	Albuminoid.		Nitrates.	Nitrites.			
	1897.												
18351	Jan. 25	None.	V. slight.	.03	7.35	.0012	.0034	.58	.0250	.0000	.02	3.2	.0190
18525	Feb. 17	None.	None.	.00	5.90	.0024	.0058	.57	.0280	.0000	.05	3.2	.0100
18776	Mar. 15	None.	None.	.01	6.60	.0018	.0054	.61	.0250	.0006	.05	3.2	.0100
19107	Apr. 26	None.	None.	.05	6.90	.0042	.0022	.58	.0180	.0001	.04	3.5	.0080
19256	May 17	None.	None.	.03	6.20	.0030	.0016	.57	.0250	.0000	.06	3.8	.0100
19480	June 16	None.	V. slight.	.01	7.10	.0012	.0034	.50	.0350	.0000	.08	3.2	.0070
19481	June 16	None.	V. slight.	.05	7.70	.0046	.0018	.51	.0250	.0000	.08	4.0	.0200
19845	July 21	None.	V. slight.	.04	7.30	.0036	.0030	.56	.0200	.0000	.05	3.4	.0120
20137	Aug. 18	None.	None.	.04	7.90	.0034	.0024	.56	.0180	.0000	.11	3.5	.0100
20605	Sept. 22	None.	None.	.07	7.60	.0040	.0036	.52	.0100	.0000	.07	4.4	.0170
20912	Oct. 20	None.	V. slight.	.10	6.90	.0026	.0028	.56	.0250	.0000	.07	3.4	.0110
21270	Nov. 17	V. slight.	Slight.	.09	8.20	.0046	.0058	.58	.0230	.0000	.08	4.6	.0050
21626	Dec. 22	V. slight.	V. slight.	.04	7.60	.0036	.0030	.60	.0200	.0000	.06	3.8	.0040

Averages by Years.

-	1888	-	-	.00	6.70	.0009	.0054	.46	.0273	.0003	-	-	-
-	1892	-	-	.00	6.81	.0033	.0027	.45	.0162	.0000	-	3.4	.0034*
-	1893	-	-	.01	6.86	.0036	.0022	.47	.0179	.0000	.06	3.4	.0020
-	1894	-	-	.02	6.75	.0028	.0019	.51	.0192	.0000	.06	3.1	.0044
-	1895	-	-	.03	7.15	.0036	.0024	.53	.0198	.0000	.05	3.4	.0082
-	1896	-	-	.03	7.36	.0034	.0018	.55	.0194	.0000	.06	3.6	.0157
-	1897†	-	-	.04	7.15	.0031	.0035	.57	.0222	.0001	.06	3.6	.0108

* July to December.

† Where more than one sample was collected in a month, the mean analysis for that month has been used in making the average.

Note to analyses of 1897: Odor, none.——Nos. 18351, 18525, 18776 and 21626 were collected from the well; No. 19480, from the filter-basin; the other samples from a faucet at the pumping station.

WALTHAM.

Chemical Examination of Water from the Distributing Reservoir of the Waltham Water Works.

[Parts per 100,000.]

Number.	Date of Collection.	Appearance.			Residue on Evaporation.	Ammonia.		Chlorine.	Nitrogen as		Oxygen Consumed.	Hardness.	Iron.
		Turbidity.	Sediment.	Color.		Free.	Albuminoid.		Nitrates.	Nitrites.			
	1897.												
18352	Jan. 25	Slight.	Cons.	.05	9.95	.0006	.0114	.56	.0160	.0000	.07	3.2	.0000
18526	Feb. 17	V. slight.	V. slight.	.05	6.50	.0014	.0086	.58	.0170	.0000	.07	3.2	.0100
18777	Mar. 15	Distinct.	Slight.	.07	7.30	.0006	.0158	.61	.0130	.0001	.06	3.2	.0100
18922	Mar. 31	Slight.	None.	.05	6.65	.0006	.0112	.59	.0100	.0000	.08	3.2	.0065
19108	Apr. 26	Slight.	Cons.	.07	6.00	.0014	.0158	.58	.0100	.0001	.06	3.4	.0030
19257	May 17	Slight.	V. slight.	.03	6.20	.0014	.0102	.58	.0170	.0001	.06	3.5	.0030
19482	June 16	None.	None.	.02	6.70	.0006	.0094	.52	.0280	.0001	.11	3.4	.0030
19844	July 21	V. slight.	V. slight.	.02	7.30	.0016	.0090	.56	.0090	.0002	.08	3.5	.0000
20136	Aug. 18	None.	None.	.03	7.50	.0014	.0108	.55	.0070	.0002	.11	3.4	.0000
20606	Sept. 22	V. slight.	V. slight.	.07	7.20	.0018	.0136	.56	.0030	.0001	.11	3.5	.0040
20913	Oct. 20	V. slight.	Slight.	.12	6.90	.0004	.0138	.54	.0120	.0000	.14	3.5	.0040
21271	Nov. 17	Distinct.	Slight.	.10	7.50	.0018	.0156	.59	.0120	.0000	.09	4.4	.0040
21625	Dec. 22	Slight.	Slight.	.05	7.70	.0008	.0086	.60	.0190	.0000	.10	3.5	.0030

Averages by Years.

-	1888	-	-	.00	6.45	.0003	.0075	.46	.0248	.0003	-	-	-
-	1892	-	-	.01	6.28	.0006	.0082	.44	.0119	.0001	-	3.0	.0070*
-	1893	-	-	.04	6.72	.0006	.0074	.47	.0127	.0001	.10	3.1	.0019
-	1894	-	-	.03	6.80	.0007	.0140	.51	.0078	.0001	.09	3.1	.0032
-	1895	-	-	.04	7.00	.0016	.0085	.53	.0161	.0000	.09	3.3	.0045
-	1896	-	-	.05	7.40	.0013	.0083	.55	.0172	.0001	.07	3.4	.0099
-	1897†	-	-	.06	7.20	.0011	.0117	.57	.0135	.0001	.09	3.5	.0035

* August to December.

† Where more than one sample was collected in a month, the mean analysis for that month has been used in making the average.

NOTE to analyses of 1897: Odor, very faint or none; in May and August, fishy; on heating, a vegetable odor was developed in some of the samples. —— The samples were collected from the reservoir.

WALTHAM.

Microscopical Examination of Water from the Distributing Reservoir of the Waltham Water Works.

[Number of organisms per cubic centimeter.]

	1897.												
	Jan.	Feb.	Mar.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
Day of examination,	29	20	16	31	27	18	18	23	19	23	22	18	23
Number of sample,	18352	18526	18777	18922	19108	19257	19482	19844	20136	20606	20913	21271	21625
PLANTS.													
Diatomaceæ,	6,476	800	3,588	2,044	5,965	727	440	12	2	0	38	7	0
Asterionella,	76	264	1,556	372	5	39	60	0	0	0	2	0	0
Synedra,	6,400	536	2,032	1,672	5,960	688	380	12	2	0	24	7	0
Algæ,	0	0	1	0	0	5	2	0	45	0	6	27	0
ANIMALS.													
Infusoria,	4	0	0	31	0	2,420	140	0	0	0	0	0	0
Dinobryon,	2	0	0	31	0	2,420	136	0	0	0	0	0	0
Vermes, Rotatorian ova,	0	0	0	1	0	0	0	0	0	0	0	0	0
Crustacea, Cyclops,	0	0	0	0	0	0	0	pr.	0	0	0	0	0
Miscellaneous, Zoöglœa,	0	0	0	0	0	0	0	0	5	0	5	0	0
TOTAL,	6,480	800	3,589	2,076	5,965	3,152	582	12	52	0	49	34	0

Chemical Examination of Water from Charles River at Waltham.

[Parts per 100,000.]

Number.	Date of Collection.	Appearance.			Residue on Evaporation.		Ammonia.				Chlorine.	Nitrogen as		Oxygen Consumed.	Hardness.
								Albuminoid.							
		Turbidity.	Sediment.	Color.	Total.	Loss on Ignition.	Free.	Total.	Dissolved.	Sus-pended.		Nitrates.	Nitrites.		
	1897.														
18921	Mar. 31	V. slight.	V. slight.	0.80	3.95	1.65	.0006	.0250	.0240	.0010	.37	.0030	.0001	0.67	1.3
19755	July 9	V. slight.	V. slight.	1.20	5.70	2.45	.0096	.0362	.0298	.0064	.43	.0000	.0002	0.99	1.8
19843	July 21	Slight.	Slight.	1.05	5.40	2.10	.0084	.0330	.0280	.0050	.44	.0030	.0002	0.76	1.8
20135	Aug. 18	Slight.	V. slight.	1.20	6.55	2.85	.0054	.0364	.0352	.0012	.46	.0030	.0002	1.07	1.8
20604	Sept. 22	V. slight.	V. slight.	0.88	6.05	2.45	.0052	.0318	.0302	.0016	.48	.0020	.0001	0.74	1.9
20911	Oct. 20	V. slight.	Slight.	0.48	5.80	1.90	.0050	.0232	.0212	.0020	.68	.0150	.0001	0.56	2.0
21269	Nov. 17	Slight.	Slight.	1.05	6.35	2.80	.0034	.0350	.0342	.0008	.62	.0150	.0002	0.92	2.2
21624	Dec. 22	V. slight.	Slight.	1.10	5.60	2.35	.0014	.0302	.0264	.0038	.44	.0130	.0001	0.90	1.8
Av.*	....	....	....	0.95	5.69	2.32	.0043	.0309	.0286	.0023	.50	.0075	.0001	0.82	1.8

* Where more than one sample was collected in a month, the mean analysis for that month has been used in making the average.

Odor, distinctly vegetable. —— The samples were collected from the river, near the pumping station of the Waltham Water Works.

WARE.

WATER SUPPLY OF WARE.

Chemical Examination of Water from the Wells of the Ware Water Works.

[Parts per 100,000.]

Number.	Date of Collection.	Appearance.			Residue on Evaporation.	Ammonia.		Chlorine.	Nitrogen as		Oxygen Consumed.	Hardness.	Iron.
		Turbidity.	Sediment.	Color.		Free.	Albuminoid.		Nitrates.	Nitrites.			
	1897.												
18875	Mar. 25	None.	Slight.	.00	11.90	.0000	.0006	.81	.2600	.0000	.00	3.2	.0150
18876	Mar. 25	None.	None.	.00	7.50	.0002	.0006	.35	.1000	.0000	.00	1.8	.0000
19594	June 28	None.	None.	.00	5.70	.0006	.0012	.40	.1340	.0000	.04	1.9	.0000
20658	Sept. 28	None.	V. slight.	.02	5.50	.0002	.0008	.15	.0200	.0000	.01	1.8	.0100
20659	Sept. 28	None.	None.	.00	7.50	.0002	.0008	.55	.1600	.0000	.02	2.7	.0020
21698	Dec. 29	None.	None.	.01	6.50	.0002	.0006	.46	.2080	.0000	.01	2.7	.0010
21699	Dec. 29	V. slight.	Cons.	.01	6.20	.0002	.0006	.44	.2200	.0000	.00	2.6	.0030

Odor, none. —— No. 18875 was collected from the large well; Nos. 18876, 20658 and 21699 from one of the tubular wells; the others, from a faucet at the pumping station, while pumping from the large well and tubular wells.

Chemical Examination of Water from the Open Distributing Reservoir of the Ware Water Works.

[Parts per 100,000.]

Number.	Date of Collection.	Appearance.			Residue on Evaporation.	Ammonia.		Chlorine.	Nitrogen as		Oxygen Consumed.	Hardness.	Iron.
		Turbidity.	Sediment.	Color.		Free.	Albuminoid.		Nitrates.	Nitrites.			
	1897.												
19595	June 28	V. slight.	Slight.	.00	6.80	.0028	.0114	.42	.1340	.0008	.14	2.2	.0000

Odor, none. —— The samples were collected from the reservoir.

WAREHAM.

The advice of the State Board of Health to Joseph K. Nye, with reference to a proposed water supply for the towns of Wareham, Marion, Mattapoisett and Fairhaven, may be found on pages 47 to 49 of this volume. The results of analyses of samples of water from the proposed sources of supply may be found in the following tables and also under Fairhaven in this volume: —

WATER SUPPLY OF ONSET BAY FIRE DISTRICT, WAREHAM. — ONSET WATER COMPANY.

Chemical Examination of Water from Jonathan's Pond, Wareham.

[Parts per 100,000.]

Number.	Date of Collection.	Appearance.			Residue on Evaporation.		Ammonia.				Chlorine.	Nitrogen as		Oxygen Consumed.	Hardness.
								Albuminoid.							
		Turbidity.	Sediment.	Color.	Total.	Loss on Ignition.	Free.	Total.	Dissolved.	Suspended.		Nitrates.	Nitrites.		
20250	1897. Aug. 23	None.	V. slight.	.02	2.15	0.70	.0008	.0096	.0092	.0004	.68	.0000	.0000	.05	0.2

Odor, faintly vegetable, becoming faintly unpleasant on heating. —— The sample was collected from a faucet at the pumping station.

Chemical Examination of Water from Spectacle Pond and Agawam River, in Wareham.

[Parts per 100,000.]

Number.	Date of Collection.	Appearance.			Residue on Evaporation.		Ammonia.				Chlorine.	Nitrogen as		Oxygen Consumed.	Hardness.
								Albuminoid.							
		Turbidity.	Sediment.	Color.	Total.	Loss on Ignition.	Free.	Total.	Dissolved.	Suspended.		Nitrates.	Nitrites.		
21510	1897. Dec. 13	V. slight.	V. slight.	.29	2.55	1.20	.0006	.0146	.0124	.0022	.62	.0020	.0000	.16	0.3
21511	Dec. 13	V. slight.	V. slight.	.14	2.45	1.05	.0006	.0238	.0162	.0076	.68	.0080	.0000	.20	0.3
21512	Dec. 13	V. slight.	Cons.	.30	2.90	1.40	.0016	.0132	.0108	.0024	.62	.0030	.0000	.18	0.3

Odor of the first sample, none; of the second, decidedly mouldy and disagreeable; of the last, faintly vegetable. —— The first sample was collected from Iron Works Pond on the Agawam River, in the town of Wareham; the second sample, from Spectacle Pond at its outlet into Iron Works Pond; the last sample, from the Agawam River, at the outlet of Glen Pond, about 2 miles above Iron Works Pond.

Microscopical Examination.

No. 21510. Diatomaceæ, *Asterionella*, 66; *Cyclotella*, 16; *Fragilaria*, 8; *Melosira*, 10; *Meridion*, 4; *Navicula*, 2; *Synedra*, 18; *Tabellaria*, 4. Cyanophyceæ, *Microcystis*, 2. Algæ, *Arthrodesmus*, 4; *Protococcus*, 52; *Scenedesmus*, 2. Infusoria, *Dinobryon*, 14. Vermes, *Anurea*, 2. Miscellaneous, *Zoöglœa*, 10. Total, 214.

No. 21511. Diatomaceæ, *Asterionella*, 18; *Melosira*, 8; *Synedra*, 240; *Tabellaria*, 6. Cyanophyceæ, *Anabæna*, 4. Algæ, *Protococcus*, 16. Infusoria, *Dinobryon*, 2; *Peridinium*, 18; *Trachelomonas*, 2. Vermes, *Anurea*, 2. Miscellaneous, *Zoöglœa*, 10. Total, 326.

No. 21512. Diatomaceæ, *Asterionella*, 38; *Cyclotella*, 28; *Fragilaria*, 6; *Melosira*, 12; *Meridion*, 10; *Navicula*, 4; *Synedra*, 42. Cyanophyceæ, *Anabæna*, 4; *Microcystis*, 2. Algæ, *Arthrodesmus*, 4; *Protococcus*, 26; Miscellaneous, *Zoöglœa*, 20. Total, 196.

WATERTOWN.

Water Supply of Watertown and Belmont.

The works of the Watertown Water Supply Company were taken by the town July 31, 1897.

The advice of the State Board of Health to the Watertown Water Supply Company, with reference to the filtration of water obtained from the tubular wells near the Charles River, in order to remove the iron from the water, may be found on pages 49 and 50 of this volume.

Chemical Examination of Water from a Faucet in the Pumping Station of the Watertown Water Works.

[Parts per 100,000.]

Number.	Date of Collection.	Appearance.			Residue on Evaporation.	Ammonia.		Chlorine.	Nitrogen as		Oxygen Consumed.	Hardness.	Iron.
		Turbidity.	Sediment.	Color.		Free.	Albuminoid.		Nitrates.	Nitrites.			
	1897.												
18338	Jan. 25	None.	None.	.00	10.40	.0016	.0140	.92	.2850	.0001	.04	3.5	.0050
18541	Feb. 17	None.	V. slight.	.02	9.20	.0034	.0162	.92	.1600	.0000	.08	3.8	.0100
18787	Mar. 16	None.	None.	.05	7.10	.0006	.0132	.75	.1030	.0000	.17	3.0	.0070
19013	Apr. 12	V. slight, milky.	V. slight.	.05	9.40	.0048	.0100	.84	.1700	.0000	.14	3.9	.0000
19275	May 19	None.	V. slight.	.00	8.80	.0004	.0058	.90	.1130	.0000	.02	3.9	.0100
19491	June 16	None.	V. slight.	.12	7.50	.0046	.0150	.64	.0650	.0000	.19	3.5	.0200
19860	July 21	V. slight.	V. slight.	.21	7.50	.0092	.0106	.63	.0300	.0000	.22	3.4	.0350
20603	Sept. 22	Slight, milky.	Slight.	.40	7.90	.0132	.0140	.76	.0150	.0001	.29	3.9	.0650
20897	Oct. 20	Distinct, milky.	Slight.	.68	9.10	.0060	.0102	.74	.0580	.0000	.23	3.5	.1100
21268	Nov. 17	Decided.	Cons.	.40	8.60	.0194	.0152	.76	.0200	.0001	.29	4.4	.0400
21631	Dec. 22	V. slight.	V. slight.	.05	10.60	.0014	.0100	.97	.3480	.0000	.04	4.3	.0020

Averages by Years.

-	1888	-	-	.00	7.22	.0000	.0040	.63	.0647	.0000	-	-	-
-	1893	-	-	.19	7.95	.0063	.0061	.66	.0489	.0001	.13	3.5	.0315
-	1894	-	-	.11	8.82	.0048	.0054	.70	.0542	.0001	.12	3.8	.0516
-	1895	-	-	.20	8.75	.0051	.0077	.69	.0669	.0003	.16	3.7	.0527
-	1896	-	-	.40	8.61	.0147	.0070	.71	.0492	.0001	.17	3.8	.1372
-	1897	-	-	.18	8.74	.0059	.0122	.80	.1243	.0000	.16	3.7	.0276

Note to analyses of 1897: Odor in October and November, faintly unpleasant, becoming stronger on heating; of the others, none.——The samples were collected from a faucet at the pumping station.

WATERTOWN.

Microscopical Examination of Water from a Faucet in the Pumping Station of the Watertown Water Works.

[Number of organisms per cubic centimeter.]

	1897.										
	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Sept.	Oct.	Nov.	Dec.
Day of examination,	27	20	18	15	20	19	23	23	21	18	23
Number of sample,	18338	18541	18787	19013	19275	19491	19860	20603	20897	21268	21631
PLANTS.											
Fungi, Crenothrix,	0	0	24	0	0	0	100	0	200	500	0

Chemical Examination of Water from a Faucet in Watertown supplied from the Watertown Water Works.

[Parts per 100,000.]

Number.	Date of Collection.	Appearance. Turbidity.	Appearance. Sediment.	Appearance. Color.	Residue on Evaporation.	Ammonia. Free.	Ammonia. Albuminoid.	Chlorine.	Nitrogen as Nitrates.	Nitrogen as Nitrites.	Oxygen Consumed.	Hardness.	Iron.
	1897.												
18247	Jan. 13	V slight, milky.	None.	.15	10.40	.0006	.0062	.82	.0880	.0001	.05	4.2	.0550
18431	Feb. 3	Slight, milky.	V. slight.	.08	7.80	.0000	.0046	.67	.0850	.0000	.09	3.5	.0300
18701	Mar. 3	Slight.	None.	.12	7.90	.0006	.0056	.72	.0800	.0000	.06	3.8	.0300
18982	Apr. 7	None.	None.	.07	7.10	.0008	.0082	.69	.0970	.0000	.12	3.4	.0090
19178	May 5	None.	None.	.12	7.90	.0010	.0048	.66	.0580	.0000	.13	4.2	.0120
19368	June 1	V. slight, milky.	None.	.05	8.30	.0006	.0044	.60	.0500	.0000	.12	4.6	.0080
19724	July 6	None.	None.	.15	8.10	.0000	.0048	.59	.0400	.0000	.12	4.3	.0100
20008	Aug. 4	V. slight.	V. slight.	.08	8.80	.0000	.0036	.70	.0650	.0000	.07	4.6	.0070
20391	Sept. 7	V. slight, milky.	None.	.23	9.30	.0000	.0080	.73	.0300	.0000	.18	4.3	.0000
20744	Oct. 5	V. slight, milky.	None.	.20	8.50	.0000	.0078	.58	.0400	.0000	.15	4.2	.0130
21036	Nov. 2	Distinct, milky.	None.	.35	8.90	.0014	.0080	.76	.0350	.0000	.16	4.3	.0210
21451	Dec. 6	Decided.	None.	.20	8.80	.0002	.0076	.72	.0560	.0000	.13	4.7	.0110

Averages by Years.

–	1893	–	–	.09	8.06	.0012	.0052	.61	.0426	.0001	.13	3.7	.0165
–	1894	–	–	.11	9.32	.0001	.0042	.71	.0490	.0000	.10	4.6	.0177
–	1895	–	–	.13	9.52	.0018	.0051	.75	.0678	.0001	.10	4.6	.0312
–	1896	–	–	.24	8.97	.0008	.0052	.71	.0581	.0000	.15	4.1	.1041
–	1897	–	–	.15	8.48	.0004	.0061	.69	.0603	.0000	.11	4.2	.0172

NOTE to analyses of 1897: Odor in September, faintly unpleasant; at other times, none. —— The samples were collected from a faucet in a house in the easterly part of Watertown.

WAYLAND.

Water Supply of Wayland.

Chemical Examination of Water from the Filter-gallery of the Wayland Water Works.

[Parts per 100,000.]

Number.	Date of Collection.	Appearance.			Residue on Evaporation.	Ammonia.		Chlorine.	Nitrogen as		Oxygen Consumed.	Hardness.	Iron.
		Turbidity.	Sediment.	Color.		Free.	Albuminoid.		Nitrates.	Nitrites.			
	1897.												
19009	Apr. 13	V. slight.	V. slight.	0.65	4.90	.0020	.0136	.45	.1050	.0014	.53	1.7	–
19916	July 26	V. slight.	V. slight.	1.10	5.00	.0050	.0246	.31	.0200	.0001	.53	1.7	.0540
20824	Oct. 18	V. slight.	V. slight.	0.47	4.40	.0016	.0198	.34	.0230	.0000	.66	–	.0300
Av...	....	....	....	0.74	4.77	.0029	.0193	.37	.0493	.0005	.57	1.7	.0420

Odor, distinctly vegetable.—The samples were collected from a faucet in the gate-house.

Microscopical Examination.

No. 19009. Diatomaceæ, *Melosira*, 2; *Synedra*, 20; *Tabellaria*, 1. Algæ, *Protococcus*, 1; *Staurastrum*, 1. Infusoria, *Dinobryon*, 4; *Peridinium*, 4. Miscellaneous, *Zoöglœa*, 5. Total, 38.

No. 19916. Diatomaceæ, *Melosira*, 12; *Synedra*, 1. Cyanophyceæ, *Anabæna*, 24. Algæ, *Protococcus*, 1; *Scenedesmus*, 1. Miscellaneous, *Zoöglœa*, 80. Total, 119.

No. 20824. Diatomaceæ, *Cyclotella*, 5; *Synedra*, 8; *Tabellaria*, 4. Algæ, *Scenedesmus*, 1; *Staurastrum*, 1. Infusoria, *Euglena*, 1. Miscellaneous, *Zoöglœa*, 10. Total, 30.

Chemical Examination of Water from the Storage Reservoir of the Wayland Water Works.

[Parts per 100,000.]

Number.	Date of Collection.	Appearance.			Residue on Evaporation.		Ammonia.				Chlorine.	Nitrogen as		Oxygen Consumed.	Hardness.
								Albuminoid.							
		Turbidity.	Sediment.	Color.	Total.	Loss on Ignition.	Free.	Total.	Dissolved.	Suspended.		Nitrates.	Nitrites.		
	1897.														
19010	Apr. 13	V. slight.	V. slight.	0.80	3.00	1.45	.0010	.0184	.0176	.0008	.21	.0030	.0000	.68	1.1
19915	July 26	V. slight.	V. slight.	1.10	4.80	2.10	.0006	.0336	.0288	.0048	.31	.0170	.0000	.98	1.7
20823	Oct. 18	Slight.	V. slight.	0.47	3.90	2.05	.0008	.0260	.0230	.0030	.30	.0250	.0000	.66	–
Av...	....	....	....	0.79	3.90	1.87	.0008	.0260	.0231	.0029	.27	.0150	.0000	.77	1.4

Odor, distinctly vegetable.—The samples were collected from the reservoir, at the surface.

Water Supply of Webster.

Chemical Examination of Water from the Well of the Webster Water Works.

[Parts per 100,000.]

Number.	Date of Collection.	Appearance.			Residue on Evaporation.	Ammonia.		Chlorine.	Nitrogen as		Oxygen Consumed.	Hardness.	Iron.
		Turbidity.	Sediment.	Color.		Free.	Albuminoid.		Nitrates.	Nitrites.			
	1897.												
18334	Jan. 22	None.	None.	.00	4.10	.0000	.0012	.22	.0180	.0000	.01	1.1	.0060
19253	May 14	None.	None.	.00	3.90	.0016	.0024	.25	.0170	.0000	.00	1.6	.0000
19767	July 12	None.	None.	.00	3.80	.0010	.0018	.25	.0200	.0000	.00	1.1	.0060
20470	Sept. 13	None.	None.	.00	4.50	.0000	.0000	.22	.0150	.0000	.02	1.6	.0020
21247	Nov. 16	None.	V. slight.	.01	3.70	.0012	.0026	.22	.0200	.0000	.01	1.7	.0010
Av...	....	....	....	.00	4.00	.0008	.0016	.23	.0180	.0000	.01	1.4	.0030

Odor of the last sample, faintly earthy; of the others, none. —— No. 18334 was collected from a faucet at the pumping station; the others, from the well.

Water Supply of Wellesley.

The capacity of the works for supplying the town of Wellesley with water was increased in the year 1897 by sinking 33 tubular wells in the valley of Rosemary Brook, above the filter-gallery of the Wellesley Water Works. The first well was about one-quarter of a mile above the filter-gallery, and the wells extended from this point about 1,500 feet up the valley of the brook to within about 350 feet of the outlet of Longfellow's Pond. The wells are $2\frac{1}{2}$ inches in diameter, and are sunk to depths of from 30 to 60 feet beneath the surface.

The advice of the State Board of Health to the town of Wellesley, with reference to the use of water taken from the ground in the valley of Rosemary Brook, may be found on pages 51 to 53 of this volume.

Chemical Examination of Water from the Filter-gallery of the Wellesley Water Works.

[Parts per 100,000.]

Number.	Date of Collection.	Appearance.			Residue on Evaporation.	Ammonia.		Chlorine.	Nitrogen as		Oxygen Consumed.	Hardness.	Iron.
		Turbidity.	Sediment.	Color.		Free.	Albuminoid.		Nitrates.	Nitrites.			
	1897.												
19465	June 15	None.	None.	.01	6.10	.0014	.0050	.49	.0650	.0000	.07	2.9	.0000
20838	Oct. 19	None.	None.	.00	7.40	.0004	.0018	.66	.0580	.0000	.06	3.4	.0000

Odor, none. —— The samples were collected from the filter-gallery.

WELLESLEY.

Chemical Examination of Water from the Well of the Wellesley Water Works.

[Parts per 100,000.]

Number.	Date of Collection.	Appearance.			Residue on Evaporation.	Ammonia.		Chlorine.	Nitrogen as		Oxygen Consumed.	Hardness.	Iron.
		Turbidity.	Sediment.	Color.		Free.	Albuminoid.		Nitrates.	Nitrites.			
	1897.												
19466	June 15	None.	V. slight.	.00	6.10	.0010	.0044	.54	.0750	.0000	.12	2.5	.0000
20837	Oct. 19	None.	V. slight.	.02	6.80	.0008	.0030	.77	.0450	.0000	.09	2.9	.0000

Odor, none. —— The samples were collected from the well, at Williams Spring.

Water Supply of Westborough.

Chemical Examination of Water from the Upper Sandra Pond, Westborough.

[Parts per 100,000.]

Number.	Date of Collection.	Appearance.			Residue on Evaporation.		Ammonia.				Chlorine.	Nitrogen as		Oxygen Consumed.	Hardness.
								Albuminoid.							
		Turbidity.	Sediment.	Color.	Total.	Loss on Ignition.	Free.	Total.	Dissolved.	Suspended.		Nitrates.	Nitrites.		
	1897.														
19384	June 4	Slight.	Cons.	.30	2.65	1.50	.0004	.0354	.0190	.0164	.12	.0030	.0000	.42	0.2
19783	July 13	Distinct.	Cons.	.38	3.00	1.50	.0004	.0400	.0214	.0186	.15	.0010	.0000	.58	0.6
20960	Oct. 25	Slight.	Slight.	.37	3.45	2.45	.0002	.0286	.0256	.0030	.21	.0030	.0000	.54	0.5
Av...	....	....	....	.35	3.03	1.82	.0003	.0347	.0220	.0127	.16	.0023	.0000	.51	0.4

Odor of the first sample, decidedly fishy and unpleasant; of the second, distinctly unpleasant; of the last, distinctly vegetable, becoming also fishy on heating. —— The first two samples were collected from the upper reservoir, and the last sample from a faucet supplied from this reservoir.

Microscopical Examination.

No. 19384. Diatomaceæ, *Melosira*, 748; *Navicula*, 20; *Synedra*, 324. Cyanophyceæ, *Aphanizomenon*, 268; *Clathrocystis*, 3. Algæ, *Dictyosphærium*, 24; *Pediastrum*, 4; *Protococcus*, 32; *Raphidium*, 212; *Scenedesmus*, 36; *Selenastrum*, 76; *Staurastrum*, 416. Infusoria, *Cryptomonas*, 4; *Dinobryon*, 8; *Peridinium*, 8. Miscellaneous, *Zoöglœa*, 120. Total, 2,303.

No. 19783. Diatomaceæ, *Melosira*, 1,084; *Pinnularia*, 6; *Stauroneis*, 4; *Synedra*, 64. Cyanophyceæ, *Clathrocystis*, 16. Algæ, *Arthrodesmus*, 4; *Dictyosphærium*, 12; *Ophiocytium*, 168; *Pediastrum*, 12; *Raphidium*, 16; *Scenedesmus*, 92; *Staurastrum*, 7,000. Infusoria, *Peridinium*, 144; *Phacus*, 1; *Trachelomonas*, 2. Miscellaneous, *Zoöglœa*, 160, Total, 8,785.

No. 20960. Diatomaceæ, *Navicula*, 2; *Synedra*, 1,200; *Tabellaria*, 4. Cyanophyceæ, *Clathrocystis*, 2. Algæ, *Protococcus*, 14; *Raphidium*, 22; *Scenedesmus*, 26; *Staurastrum*, 480. Infusoria, *Euglena*, 4; *Peridinium*, 2. Vermes, *Anurea*, 6; *Rotifer*, 2. Crustacea, *Cyclops*, pr. Miscellaneous, *Zoöglœa*, 15. Total, 1,779.

WESTBOROUGH.

Chemical Examination of Water from the Lower Sandra Pond, Westborough.

[Parts per 100,000.]

Number.	Date of Collection.	Appearance. Turbidity.	Appearance. Sediment.	Appearance. Color.	Residue on Evaporation. Total.	Residue on Evaporation. Loss on Ignition.	Ammonia. Free.	Ammonia. Albuminoid. Total.	Ammonia. Albuminoid. Dissolved.	Ammonia. Albuminoid. Suspended.	Chlorine.	Nitrogen as Nitrates.	Nitrogen as Nitrites.	Oxygen Consumed.	Hardness.
	1897.														
18509	Feb. 15	V. slight.	V. slight.	.30	3.05	1.35	.0002	.0208	.0152	.0056	.25	.0030	.0000	.33	0.8
19385	June 4	V. slight.	Cons.	.12	2.95	1.40	.0000	.0234	.0126	.0108	.15	.0030	.0000	.28	0.9

Odor of the first sample, distinctly vegetable and mouldy, becoming faintly fishy on heating; of the last, distinctly fishy. —— The first sample was collected from a faucet in the town, supplied from the lower reservoir; the last sample, from the reservoir.

Microscopical Examination.

No. 18509. Diatomaceæ, *Nitzschia*, 4; *Synedra*, 24; Algæ; *Scenedesmus*, 2; *Staurastrum*, 2; Infusoria, *Dinobryon*, 7; *Euglena*, 2; *Peridinium*, 68; *Tintinnidium*, 2. Vermes, *Anurea*, 2. Miscellaneous, *Zoöglœa*, 70. Total, 183.

No. 19385. Diatomaceæ, *Cocconeis*, 4; *Cymbella*, 10; *Epithemia*, 2; *Melosira*, 40; *Navicula*, 10; *Pleurosigma*, 4; *Synedra*, 284; Cyanophyceæ, *Aphanizomenon*, 180. Algæ, *Conferva*, 4; *Dictyosphærium*, 2: *Raphidium*, 176; *Scenedesmus*, 4; *Staurastrum*, 240. Infusoria, *Dinobryon*, 8; *Peridinum*, 6. Vermes, *Anurea*, 2; *Polyarthra*, 4; *Rotatorian ova*, 4. Miscellaneous, *Zoöglœa*, 80. Total, 1,064.

Water Supply of Westborough Insane Hospital, Westborough.

Chemical Examination of Water from the Tubular Wells at the Westborough Insane Hospital.

[Parts per 100,000.]

Number.	Date of Collection.	Appearance. Turbidity.	Appearance. Sediment.	Appearance. Color.	Residue on Evaporation.	Ammonia. Free.	Ammonia. Albuminoid.	Chlorine.	Nitrogen as Nitrates.	Nitrogen as Nitrites.	Oxygen Consumed.	Hardness.	Iron.
	1897.												
18880	Mar. 25	Distinct, milky.	V. slight.	.50	11.20	.0818	.0048	.40	.0000	.0000	.09	6.1	.1200
19564	June 23	Slight, milky.	Slight.	.55	12.00	.1280	.0050	.36	.0000	.0000	.08	6.6	.1400
20637	Sept. 27	Slight, milky.	Slight, rusty.	.60	11.30	.0632	.0044	.79	.0000	.0001	.15	6.9	.2950
Av...	....	....	....	.55	11.50	.0910	.0047	.52	.0000	.0000	.11	6.5	.1850

Odor of the first and last samples, distinctly unpleasant; of the second, faintly mouldy. —— The samples were collected from a faucet at the pumping station, while pumping from the wells.

WESTBOROUGH.

Chemical Examination of Water from Chauncy Pond, Westborough.

[Parts per 100,000.]

Number.	Date of Collection.	Appearance.			Residue on Evaporation.		Ammonia.				Chlorine.	Nitrogen as		Oxygen Consumed.	Hardness.
		Turbidity.	Sediment.	Color.	Total.	Loss on Ignition.	Free.	Albuminoid. Total.	Albuminoid. Dissolved.	Albuminoid. Suspended.		Nitrates.	Nitrites.		
	1897.														
21680	Dec. 28	V. slight.	V. slight.	.56	4.50	1.80	.0078	.0282	.0260	.0022	.45	.0130	.0000	.60	2.0

Odor, faintly vegetable and musty.——The sample was collected from a faucet at the pumping station, while pumping from the pond.

Water Supply of Westfield.

Chemical Examination of Water from the Storage Reservoir of the Westfield Water Works.

[Parts per 100,000.]

Number.	Date of Collection.	Appearance.			Residue on Evaporation.		Ammonia.				Chlorine.	Nitrogen as		Oxygen Consumed.	Hardness.
		Turbidity.	Sediment.	Color.	Total.	Loss on Ignition.	Free.	Albuminoid. Total.	Albuminoid. Dissolved.	Albuminoid. Suspended.		Nitrates.	Nitrites.		
	1897.														
18455	Feb. 8	V. slight.	Slight.	.03	1.05	0.30	.0048	.0112	.0092	.0020	.17	.0030	.0000	.09	0.0
18960	April 5	V. slight.	Slight.	.40	2.15	0.80	.0004	.0126	.0084	.0042	.08	.0030	.0000	.38	0.3
19589	June 27	V. slight.	V. slight.	.64	2.15	1.25	.0014	.0218	.0168	.0050	.02	.0030	.0000	.65	0.2
20319	Aug. 30	V. slight.	Slight.	.68	2.75	1.55	.0018	.0306	.0282	.0024	.07	.0000	.0000	.70	0.3
20994	Oct. 27	V. slight.	Cons.	.60	2.75	1.25	.0034	.0202	.0184	.0018	.12	.0170	.0000	.54	0.6
21710	Dec. 29	Slight.	V. slight.	.90	3.55	1.75	.0004	.0192	.0178	.0014	.17	.0050	.0000	.68	1.0
Av...	....	....	....	.54	2.40	1.15	.0020	.0193	.0165	.0028	.10	.0052	.0000	.51	0.8

Odor in June, none; at other times, vegetable.——The samples were collected from the storage reservoir.

Microscopical Examination of Water from the Storage Reservoir of the Westfield Water Works.

[Number of organisms per cubic centimeter.]

	1897.					
	Feb.	Apr.	June.	Aug.	Oct.	Dec.
Day of examination,	10	7	30	31	29	30
Number of sample,	18455	18960	19589	20319	20994	21710
PLANTS.						
Diatomaceæ,	**0**	**3**	**87**	**270**	**246**	**0**
Asterionella,	0	0	10	122	44	0
Cyclotella,	0	0	0	0	52	0
Tabellaria,	0	0	76	148	138	0

WESTFIELD.

Microscopical Examination of Water from the Storage Reservoir of the Westfield Water Works — Concluded.

[Number of organisms per cubic centimeter.]

	1897.					
	Feb.	Apr.	June.	Aug.	Oct.	Dec.
PLANTS — Con.						
Cyanophyceæ,	0	0	28	34	4	0
Anabæna,	0	0	28	30	0	0
Algæ,	3	4	14	44	138	0
ANIMALS.						
Rhizopoda, Actinophrys,	0	2	0	0	0	0
Infusoria,	0	7	2	48	26	4
Dinobryon,	0	0	0	34	14	3
Vermes,	0	0	1	0	0	1
Crustacea,	0	0	pr.	0	pr.	1
Miscellaneous, Zoöglœa,	0	5	40	20	8	3
TOTAL,	3	21	172	416	422	9

WATER SUPPLY OF WESTON. — WESTON AQUEDUCT COMPANY.

Chemical Examination of Water from the Well of the Weston Aqueduct Company.

[Parts per 100,000.]

Number.	Date of Collection.	Appearance.			Residue on Evaporation.	Ammonia.		Chlorine.	Nitrogen as		Oxygen Consumed.	Hardness.	Iron.
		Turbidity.	Sediment.	Color.		Free.	Albuminoid.		Nitrates.	Nitrites.			
	1897.												
18419	Feb. 1	None.	None.	.00	5.70	.0002	.0006	.44	.0500	.0000	.00	2.5	.0000
18544	Feb. 17	None.	None.	.00	6.40	.0000	.0014	.43	.0400	.0000	.03	2.7	.0000
18721	Mar. 8	V. slight.	V. slight.	.00	5.00	.0000	.0020	.48	.0600	.0000	.02	2.3	.0000
18989	April 12	None.	None.	.03	5.80	.0004	.0014	.43	.0520	.0000	.03	2.6	.0000
19296	May 19	None.	None.	.00	5.40	.0000	.0012	.45	.0470	.0000	.00	2.6	.0040
19543	June 21	None.	V. slight.	.00	5.20	.0000	.0004	.40	.0400	.0000	.01	2.5	.0030
19760	July 11	None.	V. slight.	.00	5.50	.0006	.0030	.42	.0600	.0000	.04	2.3	.0000
20118	Aug. 16	None.	V. slight.	.01	5.90	.0004	.0008	.40	.0300	.0000	.02	2.6	.0020
20492	Sept. 14	None.	None.	.00	6.30	.0002	.0002	.38	.0300	.0000	.03	2.2	.0000
20810	Oct 13	V. slight.	V. slight.	.03	7.00	.0032	.0044	.44	.0400	.0000	.03	3.3	.0000
21102	Nov. 9	None.	V. slight.	.01	6.70	.0010	.0044	.48	.0530	.0000	.04	3.8	.0010
21501	Dec. 13	V. slight.	V. slight.	.05	8.00	.0008	.0074	.52	.0400	.0000	.06	4.7	.0010
Av.	....	....	....	.01	6.07	.0006	.0023	.44	.0452	.0000	.03	2.8	.0009

Odor, none. —— The samples were collected from the well.

WESTON.

The advice of the State Board of Health to Charles W. Hubbard, with reference to a proposed water supply for several houses in the south-easterly portion of the town of Weston may be found on pages 53 to 55 of this volume. The results of analyses of samples of water collected during the investigations are given in the following tables: —

Chemical Examination of Water from a Pond in the Southerly Part of Weston.

[Parts per 100,000.]

Number.	Date of Collection.	Appearance.			Residue on Evaporation.		Ammonia.				Chlorine.	Nitrogen as		Oxygen Consumed.	Hardness.
								Albuminoid							
		Turbidity.	Sediment.	Color.	Total.	Loss on Ignition	Free.	Total.	Dissolved.	Sus-pended.		Nitrates.	Nitrites.		
	1897.														
20685	Sept. 30	Slight.	Cons.	1.10	3.95	2.75	.0200	.0600	.0496	.0104	.27	.0000	.0002	.96	0.9

Odor, distinctly mouldy and unpleasant. —— The sample was collected from a pond on the estate of Charles W. Hubbard, in Weston, about 4,000 feet north-west of the Wellesley Farms station, on the Boston & Albany Railroad.

Chemical Examination of Water from Tubular Test Wells in the Southerly Part of Weston.

[Parts per 100,000.]

Number.	Date of Collection.	Appearance.			Residue on Evaporation.	Ammonia.		Chlorine.	Nitrogen as		Oxygen Consumed.	Hardness.	Iron.
		Turbidity.	Sediment.	Color.		Free.	Albu-minoid.		Nitrates.	Nitrites.			
	1897.												
20686	Sept. 30	V. slight, milky.	V. slight.	.03	3.90	.0006	.0054	.32	.0000	.0000	.02	2.2	.0020
20687	Sept. 30	V. slight.	V. slight.	.31	6.90	.0038	.0236	.48	.0130	.0000	.37	4.6	.0040

Odor, faintly musty. —— The samples were collected from tubular test wells located in the valley of a brook flowing through the estate of Charles W. Hubbard, in Weston, and entering the Charles River about 1,800 feet north of the Wellesley Farms station on the Boston & Albany Railroad. The first sample was collected from a well located about half a mile from the mouth of the brook; the second, from a well located about one-third of a mile from the mouth of the brook.

Water Supply of West Springfield.

Chemical Examination of Water from a Faucet supplied from the Reservoir of the West Springfield Water Works.

[Parts per 100,000.]

Number.	Date of Collection.	Appearance.			Residue on Evaporation.		Ammonia.				Chlorine.	Nitrogen as		Oxygen Consumed.	Hardness.
		Turbidity.	Sediment.	Color.	Total.	Loss on Ignition.	Free.	Albuminoid. Total.	Albuminoid. Dissolved.	Albuminoid. Suspended.		Nitrates	Nitrites.		
	1897.														
18728	Mar. 9	Slight.	Slight.	.20	4.45	1.05	.0000	.0186	.0074	.0112	.14	.0000	.0000	.16	2.5
20317	Aug. 28	V. slight.	Slight.	.21	5.30	1.35	.0030	.0128	.0084	.0044	.11	.0050	.0000	.26	2.6
20752	Oct. 11	V slight.	V. slight.	.20	5.20	–	.0014	.0130	–	–	.14	.0030	.0000	.48	3.1
Av..	....	....	....	.20	4.87*	1.20	.0015	.0157*	.0079	.0078	.13	.0027	.0000	.30	2.7

* Exclusive of No. 20752.

Odor of the first sample, distinctly fishy; of the second, distinctly vegetable and grassy; of the last, distinctly grassy. —— The samples were collected from a faucet in the town.

Microscopical Examination.

No. 18728. Diatomaceæ, *Melosira*, 36; *Nitzchia*, 40; *Synedra*, 152. Infusoria, *Dinobryon*, 12; *Euglena*, 8; *Monas*, 4; *Peridinium*, 332. Vermes, *Rotatorian ova*, 4. Miscellaneous, *Zoöglœa*, 40. Total, 628.

No. 20317. Diatomaceæ, *Meridion*, 1; *Synedra*, 19; *Tabellaria*, 2. Algæ, *Protococcus*, 5; *Raphidium*, 4. Miscellaneous, *Zoöglœa*, 40. Total, 71.

No. 20752. Diatomaceæ, *Asterionella*, 14; *Cyclotella*, 4; *Meridion*, 4; *Navicula*, 2; *Synedra*, 34; *Tabellaria*, 24. Algæ, *Scenedesmus*, 2; *Staurastrum*, 2. Infusoria, *Monas*, 2: *Trachelomonas*, 2. Vermes, *Anurea*, 2. Miscellaneous, *Zoöglœa*, 5. Total, 97.

Chemical Examination of Water from Lathrop Spring, West Springfield.

[Parts per 100,000.]

Number.	Date of Collection.	Appearance.			Residue on Evaporation.	Ammonia.		Chlorine.	Nitrogen as		Oxygen Consumed.	Hardness.	Iron.
		Turbidity.	Sediment.	Color.		Free.	Albuminoid.		Nitrates.	Nitrites.			
	1897.												
20315	Aug. 28	None.	V. slight.	.00	6.70	.0012	.0014	.13	.0150	.0000	.01	4.2	.0000
20751	Oct. 11	None.	None.	.00	7.30	.0002	.0014	.15	.0120	.0000	.02	4.9	.0010

Odor, none. —— The samples were collected from the spring.

WEST SPRINGFIELD.

Chemical Examination of Water from the Receiving Well of the West Springfield Water Works.

[Parts per 100,000.]

Number.	Date of Collection.	Appearance.			Residue on Evaporation.	Ammonia.		Chlorine.	Nitrogen as		Oxygen Consumed.	Hardness.	Iron.
		Turbidity.	Sediment.	Color.		Free.	Albuminoid.		Nitrates.	Nitrites.			
	1897.												
20316	Aug. 28	None.	Slight.	.02	8.30	.0012	.0026	.49	.1500	.0000	.00	3.5	.0060
20750	Oct. 11	None.	V. slight	.00	8.20	.0002	.0008	.61	.1160	.0000	.04	3.9	–

Odor, none. A faintly vegetable odor was developed in the second sample on heating.——The samples were collected from a faucet in the village of Mitteneague, supplied from the well.

Water Supply of West Stockbridge. — East Mountain Water Company.

Chemical Examination of Water from East Mountain Spring.

[Parts per 100,000.]

Number.	Date of Collection.	Appearance.			Residue on Evaporation.	Ammonia.		Chlorine.	Nitrogen as		Oxygen Consumed.	Hardness.	Iron.
		Turbidity.	Sediment.	Color.		Free.	Albuminoid.		Nitrates.	Nitrites.			
	1897.												
21008	Oct. 29	None.	V. slight.	.20	4.95	.0008	.0030	.09	.0000	.0000	.14	3.4	–
21701	Dec. 29	V. slight.	None.	.05	3.80	.0000	.0022	.10	.0030	.0000	.08	2.3	.0030

Odor, none, becoming faintly vegetable on heating.——The samples represent water from the East Mountain Spring, the orginal source of supply of the town of West Stockbridge. The first sample was collected from the spring, and the second sample from a faucet in the town.

Chemical Examination of Water from the Reservoir of the East Mountain Water Company near Lenox Road.

[Parts per 100,000.]

Number.	Date of Collection.	Appearance.			Residue on Evaporation.	Ammonia.		Chlorine.	Nitrogen as		Oxygen Consumed.	Hardness.	Iron.
		Turbidity.	Sediment.	Color.		Free.	Albuminoid.		Nitrates.	Nitrites.			
	1897.												
21009	Oct. 30	None.	None.	.03	10.45	.0019	.0030	.06	.0090	.0001	.02	8.9	–
21700	Dec. 29	Slight.	V. slight.	.03	7.60	.0000	.0014	.06	.0070	.0000	.01	5.6	.0020

Odor of the first sample, faintly vegetable; of the last, none.——The first sample was collected from the reservoir near Lenox Road; the last, from a faucet in the village, supplied from this reservoir.

Water Supply of Weymouth.

Chemical Examination of Water from Great Pond, in Weymouth.

[Parts per 100,000.]

Number.	Date of Collection.	Appearance.			Residue on Evaporation.		Ammonia.				Chlorine.	Nitrogen as		Oxygen Consumed.	Hardness.
		Turbidity.	Sediment.	Color.	Total.	Loss on Ignition.	Free.	Albuminoid. Total.	Albuminoid. Dissolved.	Albuminoid. Sus-pended		Nitrates.	Nitrites.		
	1897.														
18501	Feb. 15	V. slight.	Cons.	1.20	4.75	2.45	.0026	.0246	.0216	.0030	.68	.0050	.0000	.90	1.4
19142	Apr. 29	V. slight.	Slight.	0.90	3.85	2.15	.0012	.0248	.0234	.0014	.61	.0030	.0000	.78	0.5
19712	June 28	V. slight.	Cons.	1.05	4.25	2.10	.0006	.0186	.0176	.0010	.62	.0000	.0000	.83	0.3
20318	Aug. 30	None.	Slight.	0.65	3.75	1.70	.0014	.0170	.0158	.0012	.60	.0020	.0000	.75	0.6
20977	Oct. 27	V. slight.	Slight.	0.60	3.15	1.70	.0012	.0174	.0158	.0016	.68	.0070	.0000	.50	0.6
21689	Dec. 29	V. slight.	Cons.	1.10	4.75	2.45	.0008	.0200	.0198	.0002	.70	.0040	.0000	.84	1.3

Averages by Years.

Number.	Date of Collection.	Turbidity.	Sediment.	Color.	Total.	Loss on Ignition.	Free.	Albuminoid. Total.	Albuminoid. Dissolved.	Albuminoid. Sus-pended	Chlorine.	Nitrates.	Nitrites.	Oxygen Consumed.	Hardness.
–	1892	–	–	0.94	3.82	1.86	.0000	.0173	.0156	.0017	.51	.0077	.0000	–	0.4
–	1893	–	–	0.76	3.86	1.66	.0003	.0163	.0139	.0025	.57	.0008	.0000	.68	0.5
–	1894	–	–	0.77	3.99	1.60	.0003	.0169	.0156	.0013	.61	.0015	.0000	.67	0.7
–	1895	–	–	0.82	4.07	1.99	.0005	.0196	.0183	.0013	.56	.0040	.0000	.80	0.6
–	1896	–	–	0.82	4.00	1.97	.0005	.0184	.0161	.0023	.57	.0045	.0000	.78	0.6
–	1897	–	–	0.92	4.08	2.09	.0013	.0204	.0190	.0014	.65	.0035	.0000	.77	0.8

Note to analyses of 1897: Odor, vegetable. —— The samples were collected from faucets in the town, supplied with water from the pond.

Water Supply of Whitman.

The advice of the State Board of Health to the town of Whitman, with reference to the protection of the purity of the water supply of the town, may be found on pages 93 and 94 of this volume.

Chemical Examination of Water from the Filter-gallery of the Whitman Water Works.

[Parts per 100,000.]

Number.	Date of Collection	Appearance.			Residue on Evaporation.	Ammonia.		Chlorine.	Nitrogen as		Oxygen Consumed.	Hardness.	Iron.
		Turbidity.	Sediment.	Color.		Free.	Albu-minoid.		Nitrates.	Nitrites.			
	1897.												
18264	Jan. 18	V. slight.	Slight.	0.00	2.90	.0042	.0112	0.08	.0030	.0000	.02	0.0	.0050
19070	Apr. 20	V. slight.	Slight.	0.80	5.10	.0034	.0224	0.78	.0150	.0001	.72	1.6	.1100
19818	July 19	V. slight.	V. slight	1.15	6.95	.0036	.0366	0.90	.0050	.0001	.91	2.1	–
20760	Oct. 12	Slight.	V. slight.	0.47	7.80	.0068	.0310	1.27	.0280	.0000	.54	2.5	.0140
Av...	....	....	....	0.60	5.69	.0045	.0253	0.76	.0127	.0000	.55	1.5	.0430

Odor of the first sample, none; of the others, distinctly vegetable. —— No. 19818 was collected from a faucet in the town; the other samples, from the filter-gallery.

WHITMAN.

Chemical Examination of Water from Hobart's Pond, Whitman.

[Parts per 100,000.]

Number.	Date of Collection.	Appearance.			Residue on Evaporation.		Ammonia.				Chlorine.	Nitrogen as		Oxygen Consumed.	Hardness.
		Turbidity.	Sediment.	Color.	Total.	Loss on Ignition.	Free.	Albuminoid. Total.	Albuminoid. Dissolved.	Albuminoid. Suspended		Nitrates.	Nitrites.		
	1897.														
18263	Jan. 18	V. slight.	V. slight.	0.72	7.75	2.55	.0022	.0178	.0178	.0000	0.61	.0480	.0003	0.68	1.9
18657	Feb. 25	Distinct, milky.	Slight.	0.65	5.60	2.10	.0064	.0202	.0192	.0010	0.80	.0200	.0002	0.68	1.7
19069	Apr. 20	V. slight.	Slight.	0.75	4.80	2.05	.0016	.0304	.0276	.0028	0.75	.0080	.0001	0.78	1.6
19817	July 19	V. slight.	V. slight.	1.15	6.95	2.80	.0012	.0536	.0450	.0085	0.90	.0000	.0000	1.05	2.0
20759	Oct. 12	V. slight.	V. slight.	0.48	7.65	2.85	.0006	.0352	.0340	.0012	1.25	.0000	.0000	0.78	2.0
Av..	....	....	....	0.75	6.55	2.47	.0024	.0314	.0287	.0027	0.86	.0152	.0001	0.79	1.8

Odor, distinctly vegetable.—— The samples were collected from the pond.

Chemical Examination of Water from Shumatuscacant River, in Abington.

[Parts per 100,000.]

Number.	Date of Collection.	Appearance.			Residue on Evaporation.		Ammonia.				Chlorine.	Nitrogen as		Oxygen Consumed.	Hardness.
		Turbidity.	Sediment.	Color.	Total.	Loss on Ignition.	Free.	Albuminoid. Total.	Albuminoid. Dissolved.	Albuminoid. Suspended.		Nitrates.	Nitrites.		
	1897.														
18654	Feb. 25	Slight.	Slight.	0.45	4.90	1.90	.0026	.0172	.0104	.0068	.67	.0600	.0001	.42	1.2
18655	Feb. 25	None.	V. slight.	0.60	4.20	1.90	.0014	.0140	.0140	.0000	.72	.0250	.0000	.59	0.9
18656	Feb. 25	Distinct, milky.	Slight.	0.67	4.90	2.00	.0086	.0238	.0226	.0012	.66	.0150	.0001	.68	1.6

Odor, distinctly vegetable.—— The first sample was collected from the stream just above the village of North Abington; the second, from the stream at the upper end of the mill pond, just above the village of Abington; the last, from the stream at the upper end of Hobart's Pond.

WILLIAMSTOWN.

Water Supply of Williamstown. — Williamstown Water Company.

Chemical Examination of Water from Cold Spring Reservoir, Williamstown.

[Parts per 100,000.]

Number.	Date of Collection.	Appearance.			Residue on Evaporation.	Ammonia.		Chlorine.	Nitrogen as		Oxygen Consumed.	Hardness.	Iron.
		Turbidity.	Sediment.	Color.		Free.	Albuminoid.		Nitrates.	Nitrites.			
	1897.												
18618	Feb. 23	None.	None.	.00	11.50	.0002	.0006	.06	.0300	.0000	.03	6.6	.0020
19125	Apr. 27	None.	V. slight.	.00	10.40	.0000	.0014	.06	.0250	.0000	.02	8.9	.0020
19561	June 22	V. slight.	Slight.	.01	9.40	.0002	.0016	.06	.0160	.0000	.01	7.3	.0070
20271	Aug. 24	None.	None.	.00	14.10	.0004	.0004	.04	.0320	.0000	.00	11.0	.0000
20969	Oct. 26	None.	None.	.03	13.90	.0002	.0034	.09	.0600	.0000	.01	12.6	.0010
21673	Dec. 27	Decided.	Slight.	.05	10.80	.0014	.0018	.08	.0320	.0001	.02	9.1	.0000
Av...	1897	....	....	.01	11.68	.0004	.0015	.06	.0325	.0000	.01	9.2	.0020
Av...	1896	....	....	.01	12.62	.0007	.0020	.06	.0333	.0000	.02	12.2	.0026

Odor, none. A faintly vegetable odor was developed in two of the samples on heating. —— No. 20271 was collected from the reservoir; the other samples, from faucets in the town.

Chemical Examination of Water from Sherman Spring Reservoir, Williamstown.

[Parts per 100,000.]

Number.	Date of Collection.	Appearance.			Residue on Evaporation.	Ammonia.		Chlorine.	Nitrogen as		Oxygen Consumed.	Hardness.	Iron.
		Turbidity.	Sediment.	Color.		Free.	Albuminoid.		Nitrates.	Nitrites.			
	1897.												
18616	Feb. 23	None.	V. slight.	.00	10.30	.0008	.0012	.06	.0200	.0000	.00	7.4	.0010
19123	Apr. 27	None.	V. slight.	.00	7.10	.0004	.0018	.07	.0050	.0000	.02	5.3	.0000
19563	June 22	None.	V. slight.	.00	10.00	.0000	.0008	.04	.0120	.0000	.00	8.1	.0000
20273	Aug. 24	None.	Slight.	.01	8.10	.0016	.0042	.05	.0070	.0000	.04	5.9	.0000
20967	Oct. 26	None.	V slight.	.05	8.10	.0006	.0040	.06	.0220	.0001	.04	6.9	.0020
21671	Dec. 27	V. slight.	Cons.	.00	8.00	.0014	.0016	.08	.0120	.0000	.07	6.4	.0000
Av...	1897	....	....	.01	8.60	.0008	.0023	.06	.0130	.0000	.03	6.7	.0005
Av...	1896	....	....	.01	7.15	.0024	.0051	.06	.0083	.0001	.04	5.3	.0018

Odor, none. A faintly vegetable odor was developed in some of the samples on heating. —— The samples were collected from the reservoir.

WILLIAMSTOWN.

Chemical Examination of Water from Flora Glen Reservoir, Williamstown.

[Parts per 100,000.]

Number.	Date of Collection.	Appearance.			Residue on Evaporation.		Ammonia.				Chlorine.	Nitrogen as		Oxygen Consumed.	Hardness.
		Turbidity.	Sediment.	Color.	Total.	Loss on Ignition.	Free.	Albuminoid. Total.	Albuminoid. Dissolved.	Albuminoid. Suspended.		Nitrates.	Nitrites.		
	1897.														
18619	Feb. 23	V. slight, milky.	V. slight.	.03	5.20	0.75	.0002	.0032	.0026	.0006	.09	.0070	.0000	.07	3.4
19126	Apr. 27	None.	None.	.05	4.10	0.30	.0000	.0050	.0050	.0000	.06	.0030	.0000	.06	2.6
19560	June 22	Slight, milky.	V. slight.	.12	5.10	0.90	.0012	.0068	.0030	.0038	.04	.0020	.0000	.05	3.2
20270	Aug. 24	Slight.	V. slight.	.04	5.50	0.60	.0008	.0068	.0042	.0026	.08	.0000	.0000	.10	3.5
20970	Oct. 26	V. slight.	Slight.	.05	5.90	1.05	.0006	.0118	.0088	.0030	.12	.0080	.0000	.12	4.4
21674	Dec. 27	Decided.	Cons.	.11	4.50	0.50	.0016	.0038	.0036	.0002	.10	.0070	.0000	.04	2.5
Av...	1897	....	....	.07	5.05	0.68	.0007	.0062	.0045	.0017	.08	.0045	.0000	.07	3.3
Av...	1896	....	....	.04	5.31	0.40	.0011	.0070	.0052	.0018	.07	.0052	.0000	.09	3.4

Odor, faintly vegetable or none.——The samples were collected from the reservoir.

Chemical Examination of Water from Paul Brook Reservoir, Williamstown.

[Parts per 100,000.]

Number.	Date of Collection.	Appearance.			Residue on Evaporation.		Ammonia.				Chlorine.	Nitrogen as		Oxygen Consumed.	Hardness.
		Turbidity.	Sediment.	Color.	Total.	Loss on Ignition.	Free.	Albuminoid. Total.	Albuminoid. Dissolved.	Albuminoid. Suspended.		Nitrates.	Nitrites.		
	1897.														
18617	Feb. 23	None.	V. slight.	.00	4.00	–	.0016	.0022	–	–	.04	.0050	.0000	.04	3.0
19124	Apr. 27	None.	V. slight.	.00	3.00	0.40	.0006	.0020	.0020	.0000	.08	.0030	.0000	.04	2.2
19562	June 22	None.	V. slight.	.00	3.30	–	.0002	.0014	–	–	.04	.0070	.0000	.01	2.6
20272	Aug. 24	None.	None.	.00	4.60	1.40	.0004	.0018	.0006	.0012	.06	.0050	.0000	.06	2.6
20968	Oct. 26	None.	V. slight.	.06	3.80	1.15	.0008	.0042	.0034	.0008	.09	.0090	.0000	.08	2.7
21672	Dec. 27	Slight.	Cons.	.09	3.70	0.75	.0010	.0050	.0030	.0020	.06	.0080	.0000	.01	2.9
Av..	1897	....	....	.02	3.77*	0.92	.0008	.0032*	.0022	.0010	.06	.0062	.0000	.04	2.7
Av..	1896	....	....	.01	4.93	0.54	.0005	.0035	.0025	.0010	.06	.0078	.0000	.05	3.6

* Exclusive of Nos. 18617 and 19562.

Odor, none.——The samples were collected from the reservoir.

Water Supply of Winchendon.

Chemical Examination of Water from the Well of the Winchendon Water Works.

[Parts per 100,000.]

Number.	Date of Collection.	Appearance.			Residue on Evaporation.	Ammonia.		Chlorine.	Nitrogen as		Oxygen Consumed.	Hardness.	Iron.
		Turbidity.	Sediment.	Color.		Free.	Albuminoid.		Nitrates.	Nitrites.			
	1897.												
18393	Jan. 27	None.	V. slight.	.00	4.00	.0000	.0020	.14	.0050	.0000	.00	1.6	.0000
18581	Feb. 22	None.	None.	.00	2.30	.0008	.0018	.14	.0030	.0000	.02	1.3	.0000
18833	Mar. 22	None.	None.	.00	2.40	.0018	.0020	.11	.0070	.0001	.02	1.3	.0030
19115	Apr. 26	None.	V. slight.	.02	2.70	.0004	.0016	.12	.0030	.0000	.01	1.6	.0000
19313	May 24	None.	None.	.00	2.60	.0000	.0012	.12	.0030	.0000	.00	1.1	.0000
19593	June 28	None.	None.	.00	3.50	.0006	.0012	.10	.0050	.0000	.07	1.1	.0120
19940	July 27	None.	Slight.	.05	5.50	.0006	.0030	.14	.0100	.0000	.05	2.0	.0290
20284	Aug. 26	None.	None.	.00	3.50	.0002	.0022	.13	.0030	.0001	.09	1.6	.0000
20657	Sept. 28	None.	None.	.07	4.10	.0004	.0024	.11	.0000	.0000	.02	1.9	.0040
20996	Oct. 27	None.	None.	.00	3.60	.0014	.0016	.11	.0000	.0000	.01	2.0	.0040
21326	Nov. 23	None.	V slight.	.04	3.30	.0012	.0026	.12	.0040	.0000	.02	2.0	.0020
21715	Dec. 29	V. slight.	V. slight.	.02	3.70	.0002	.0012	.14	.0050	.0000	.01	2.1	.0030
Av...	....	....	....	.02	3.43	.0006	.0019	.12	.0040	.0000	.03	1.6	.0047

Odor, none. —— Nos. 18393, 18581, 18833, 19115, 19313 and 20284 were collected from the well; the others, from a faucet in the village.

Water Supply of Winchester.

Chemical Examination of Water from the North Reservoir of the Winchester Water Works.

[Parts per 100,000.]

Number.	Date of Collection.	Appearance.			Residue on Evaporation.		Ammonia.				Chlorine.	Nitrogen as		Oxygen Consumed.	Hardness.
								Albuminoid.							
		Turbidity.	Sediment.	Color.	Total.	Loss on Ignition.	Free.	Total.	Dissolved.	Suspended.		Nitrates.	Nitrites.		
	1897.														
18251	Jan. 13	Slight.	Slight	.15	14.00	3.95	.0096	.0220	.0218	.0002	.98	.0130	.0003	.36	2.7
18427	Feb. 2	V. slight.	V. slight.	.10	6.65	2.20	.0120	.0232	.0222	.0010	.84	.0180	.0001	.38	2.7
18686	Mar. 2	V. slight.	V. slight.	.10	5.95	1.70	.0110	.0230	.0210	.0020	.79	.0150	.0001	.38	2.8
18965	Apr. 6	Slight.	Slight.	.10	6.35	1.75	.0030	.0292	.0240	.0052	.78	.0250	.0002	.32	2.6
19164	May 4	Slight.	V. slight.	.12	5.80	1.30	.0024	.0254	.0242	.0012	.76	.0480	.0002	.27	2.6
19374	June 2	Slight.	Slight.	.12	6.15	1.60	.0072	.0260	.0202	.0058	.72	.0080	.0001	.25	3.0
19717	July 6	Slight.	Slight.	.05	5.85	1.50	.0050	.0282	.0228	.0054	.82	.0040	.0001	.29	2.5
19988	Aug. 3	Slight.	Slight.	.09	5.60	1.75	.0014	.0288	.0228	.0060	.73	.0000	.0000	.31	2.5
20386	Sept. 7	V. slight.	V. slight.	.05	6.25	2.05	.0012	.0250	.0228	.0022	.75	.0020	.0000	.32	2.7
20725	Oct. 6	V. slight.	V. slight.	.18	6.15	1.85	.0006	.0252	.0240	.0012	.77	.0030	.0000	.31	2.5
21032	Nov. 2	V. slight.	V. slight.	.11	5.65	1.60	.0026	.0270	.0228	.0042	.78	.0000	.0000	.30	2.5
21446	Dec. 6	V. slight.	V. slight.	.08	5.95	1.35	.0020	.0246	.0216	.0030	.82	.0090	.0001	.24	3.1

WINCHESTER.

Chemical Examination of Water from the North Reservoir of the Winchester Water Works — Concluded.

Averages by Years.

[Parts per 100,000.]

Number.	Date of Collection.	Appearance.			Residue on Evaporation.		Ammonia.				Chlorine.	Nitrogen as		Oxygen Consumed.	Hardness.
								Albuminoid.							
		Turbidity.	Sediment.	Color.	Total.	Loss on Ignition.	Free.	Total.	Dissolved.	Sus-pended.		Nitrates.	Nitrites.		
–	1888	–	–	.15	4.93	1.24	.0045	.0273	–	–	.47	.0131	.0003	–	–
–	1889	–	–	.14	4.52	1.18	.0022	.0222	.0175	.0047	.47	.0105	.0003	–	–
–	1890	–	–	.09	5.30	1.31	.0017	.0201	.0160	.0041	.52	.0153	.0002	–	2.7
–	1891	–	–	.10	4.94	1.39	.0034	.0222	.0169	.0053	.51	.0152	.0001	–	2.1
–	1892	–	–	.06	5.23	1.59	.0058	.0217	.0177	.0040	.60	.0192	.0002	–	2.5
–	1893	–	–	.07	5.13	1.62	.0055	.0252	.0172	.0080	.59	.0127	.0002	.27	2.3
–	1894	–	–	.09	5.85	1.86	.0017	.0198	.0160	.0038	.82	.0076	.0001	.25	2.5
–	1895	–	–	.11	6.50	2.05	.0024	.0203	.0169	.0034	.91	.0183	.0002	.29	2.6
–	1896	–	–	.12	6.32	1.94	.0022	.0242	.0184	.0058	.85	.0116	.0001	.32	2.6
–	1897	–	–	.10	6.70	1.88	.0048	.0256	.0225	.0031	.79	.0121	.0001	.31	2.7

NOTE to analyses of 1897: Odor, distinctly vegetable.—— The samples were collected from the reservoir, near the gate-house.

Microscopical Examination of Water from the North Reservoir of the Winchester Water Works.

[Number of organisms per cubic centimeter.]

	1897.											
	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
Day of examination,	15	5	3	7	6	4	7	4	8	8	3	6
Number of sample,	18251	18427	18686	18965	19164	19374	19717	19988	20386	20725	21032	21446
PLANTS.												
Diatomaceæ,	19	1	0	288	1,683	12	2	36	60	1,204	414	97
Asterionella,	5	1	0	16	25	0	0	0	16	1,200	388	54
Tabellaria,	12	0	0	232	1,620	3	2	2	0	0	0	3
Cyanophyceæ,	0	0	0	0	0	2	24	4	0	56	4	0
Anabæna,	0	0	0	0	0	0	12	0	0	46	0	0
Algæ,	11	0	0	3	24	138	66	92	152	0	20	41
Raphidium,	11	0	0	3	24	128	42	76	132	0	18	36
ANIMALS.												
Rhizopoda, Actinophrys,	0	0	0	0	0	0	0	0	0	0	14	1
Infusoria,	0	3	3	20	0	0	3	10	20	34	28	2
Dinobryon,	0	0	0	0	0	0	3	2	18	18	16	0
Peridinium,	0	3	2	20	0	0	0	0	2	2	0	2
Vermes,	0	0	0	0	1	0	0	0	2	2	0	0
Crustacea, Cyclops,	0	pr.	0	0	0	0	0	pr.	0	0	0	0
Miscellaneous, Zoöglœa,	5	5	10	30	10	15	5	10	3	60	5	5
TOTAL,	35	9	13	341	1,718	167	100	152	237	1,356	485	146

WINCHESTER.

Chemical Examination of Water from the South Reservoir of the Winchester Water Works.

[Parts per 100,000.]

Number.	Date of Collection.	Appearance.			Residue on Evaporation.		Ammonia.				Chlorine.	Nitrogen as		Oxygen Consumed.	Hardness.
		Turbidity.	Sediment.	Color.	Total.	Loss on Ignition.	Free.	Albuminoid. Total.	Albuminoid. Dissolved.	Albuminoid. Suspended.		Nitrates.	Nitrites.		
	1897.														
18253	Jan. 13	V. slight.	Slight.	.15	4.95	1.80	.0152	.0216	.0214	.0002	.52	.0230	.0005	.37	1.7
18429	Feb. 2	V. slight.	V. slight.	.10	4.00	1.80	.0072	.0284	.0240	.0044	.41	.0230	.0001	.39	1.6
18688	Mar. 2	V. slight.	V. slight.	.10	5.00	2.00	.0076	.0266	.0266	.0000	.47	.0170	.0001	.41	1.6
18967	Apr. 6	V. slight.	Slight.	.15	3.40	1.35	.0076	.0254	.0204	.0050	.38	.0120	.0002	.32	1.1
19166	May 4	Slight.	Slight.	.12	3.80	1.05	.0038	.0456	.0232	.0224	.38	.0150	.0002	.38	1.3
19376	June 2	V. slight.	V. slight.	.10	3.50	1.30	.0022	.0264	.0216	.0048	.32	.0030	.0000	.31	1.1
19719	July 6	Slight.	Slight.	.08	3.05	1.25	.0028	.0232	.0196	.0036	.38	.0020	.0000	.29	1.1
19990	Aug. 3	V. slight.	V slight.	.08	3.35	1.40	.0014	.0278	.0244	.0034	.37	.0020	.0000	.34	1.1
20388	Sept. 7	Slight.	Slight.	.08	3.90	1.95	.0002	.0274	.0228	.0046	.38	.0000	.0000	.38	1.6
20726	Oct. 6	V. slight.	V. slight.	.12	3.45	1.55	.0002	.0232	.0214	.0018	.35	.0000	.0000	.32	1.4
21033	Nov. 2	Slight.	Cons., floc.	.35	3.80	1.55	.0128	.0330	.0264	.0066	.36	.0000	.0000	.35	1.7
21447	Dec. 6	V. slight.	V. slight.	.41	3.70	1.70	.0120	.0296	.0238	.0058	.39	.0050	.0001	.33	2.0

Averages by Years.

-	1892	-	-	.51	5.17	2.04	.0055	.0392	.0318	.0074	.38	.0118	.0002	-	2.2
-	1893	-	-	.34	4.78	1.86	.0064	.0291	.0216	.0075	.36	.0093	.0002	.49	2.1
-	1894	-	-	.18	4.56	1.76	.0049	.0267	.0232	.0035	.41	.0024	.0001	.45	1.9
-	1895	-	-	.18	4.44	1.77	.0039	.0261	.0226	.0035	.41	.0070	.0001	.41	1.9
-	1896	-	-	.18	4.22	1.75	.0040	.0326	.0256	.0070	.37	.0036	.0000	.43	1.6
-	1897	-	-	.15	3.82	1.56	.0061	.0282	.0230	.0052	.39	.0085	.0001	.35	1.4

NOTE to analyses of 1897: Odor, generally distinctly vegetable; in May, decidedly fishy and oily. On heating, a faintly fishy odor was developed in the October sample. —— The samples were collected from the reservoir, near the gate-house.

Microscopical Examination of Water from the South Reservoir of the Winchester Water Works.

[Number of organisms per cubic centimeter.]

	1897.											
	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
Day of examination,	15	5	5	7	6	4	7	4	8	8	3	6
Number of sample,	18253	18429	18688	18967	19166	19376	19719	19990	20388	20726	21033	21447
PLANTS.												
Diatomaceæ,	**1**	**4**	**0**	**86**	**1,319**	**45**	**0**	**4**	**14**	**100**	**108**	**736**
Asterionella,	0	0	0	40	1,316	36	0	0	4	24	90	736
Synedra,	0	4	0	28	3	0	0	1	6	76	16	0
Cyanophyceæ,	**0**	**0**	**0**	**0**	**0**	**4**	**128**	**1**	**2**	**20**	**14**	**6**
Anabæna,	0	0	0	0	0	4	120	0	0	6	0	0
Cœlosphærium,	0	0	0	0	0	0	0	1	2	8	14	6
Algæ,	**0**	**2**	**0**	**8**	**4**	**6**	**116**	**11**	**28**	**20**	**18**	**4**
Botrycoccus,	0	0	0	0	0	0	64	0	0	0	0	0
Protococcus,	0	2	0	0	0	0	52	11	16	10	0	0

WINCHESTER.

Microscopical Examination of Water from the South Reservoir of the Winchester Water Works — Concluded.

[Number of organisms per cubic centimeter.]

	1897.											
	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
ANIMALS.												
Rhizopoda, Actinophrys, . .	0	0	0	0	0	0	0	0	0	2	4	0
Infusoria, ...	6	48	16	236	42	100	2	7	2	36	32	34
Dinobryon, ...	0	32	16	228	1	96	0	0	0	24	0	0
Mallomonas, ...	0	0	0	0	0	1	0	3	0	2	24	30
Peridinium, ...	4	12	0	2	0	1	2	2	0	0	2	0
Uroglena, ...	0	0	0	0	40	0	0	0	0	0	0	0
Vermes, ...	0	2	0	0	0	1	0	0	0	4	4	0
Crustacea, ...	0	0	pr.	0	pr.	0	0	0	0	pr.	0	pr.
Miscellaneous, Zoöglœa, . . .	5	5	0	40	0	15	10	10	5	20	100	10
TOTAL, ...	12	61	16	370	1,365	171	256	83	51	202	280	790

Chemical Examination of Water from the Middle Reservoir of the Winchester Water Works.

[Parts per 100,000.]

Number.	Date of Collection.	Appearance.			Residue on Evaporation.		Ammonia.				Chlorine.	Nitrogen as		Oxygen Consumed.	Hardness.
								Albuminoid.							
		Turbidity.	Sediment.	Color.	Total.	Loss on Ignition.	Free.	Total.	Dissolved.	Sus-pended.		Nitrates.	Nitrites.		
	1897.														
18252	Jan. 13	Distinct.	Cons.	.50	6.30	3.00	.0014	.0606	.0410	.0196	.52	.0100	.0001	.66	1.1
18428	Feb. 2	Slight.	V. slight.	.45	3.95	2.20	.0044	.0448	.0350	.0098	.38	.0100	.0000	.64	1.1
18687	Mar. 2	Slight.	V. slight.	.45	4.45	2.20	.0014	.0448	.0386	.0062	.42	.0130	.0000	.70	1.1
18966	Apr. 6	Distinct.	Slight.	.48	3.45	1.50	.0000	.0492	.0338	.0154	.35	.0030	.0000	.55	0.9
19165	May 4	V slight.	V. slight.	.40	3.65	1.90	.0012	.0504	.0360	.0144	.31	.0250	0000	.57	1.3
19375	June 2	Slight.	Slight.	.45	3.90	1.90	.0008	.0340	.0268	.0072	.31	.0030	.0000	.58	1.0
19718	July 6	Distinct.	Slight.	.34	3.65	1.95	.0070	.0386	.0290	.0096	.32	.0000	.0000	.52	1.0
19989	Aug. 3	Distinct.	Cons.	.49	4.05	2.05	.0116	.0590	.0364	.0226	.36	.0030	.0000	.61	1.3
20387	Sept. 7	Distinct.	Cons.	.33	5.30	3.10	.0008	.1120	.0412	.0708	.42	.0000	.0000	.66	1.6
20727	Oct. 6	Slight.	Slight.	.32	4.05	2.10	.0004	.0424	.0352	.0072	.36	.0020	.0000	.52	1.4
21034	Nov. 2	Distinct.	Slight.	.45	4.10	2.30	.0030	.0710	.0402	.0308	.39	.0030	.0001	.48	1.3
21448	Dec. 6	V. slight.	V. slight.	.31	3.75	1.65	.0018	.0424	.0374	.0050	.40	.0080	.0004	.51	1.8

Averages by Years.

-	1895	-	-	.41	4.84	2.58	.0054	.0693	.0462	.0231	.41	.0065	.0001	.70	1.3
-	1896	-	-	.41	4.45	2.28	.0004	.0524	.0373	.0151	.36	.0053	.0000	.69	1.3
-	1897	-	-	.41	4.22	2.15	.0028	.0541	.0359	.0182	.38	.0067	.0000	.58	1.2

NOTE to analyses of 1897: Odor in February and April, distinctly fishy; at other times, distinctly vegetable and occasionally grassy. On heating, a fishy odor was developed in the January and June samples, and a grassy or mouldy odor in some of the other samples.—— The samples were collected from the reservoir, near the dam.

WINCHESTER.

Microscopical Examination of Water from the Middle Reservoir of the Winchester Water Works.

[Number of organisms per cubic centimeter.]

	1897.											
	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
Day of examination,	15	5	5	7	6	4	7	4	8	8	3	6
Number of sample,	18252	18428	18687	18966	19165	19375	19718	19989	20387	20727	21034	21448
PLANTS.												
Diatomaceæ,	**96**	**152**	**868**	**581**	**196**	**156**	**259**	**14**	**24**	**106**	**106**	**84**
Asterionella,	16	32	260	124	16	4	224	6	0	78	64	36
Synedra,	52	120	608	456	180	152	32	2	8	28	12	2
Cyanophyceæ,	**0**	**0**	**0**	**0**	**0**	**0**	**60**	**42**	**6,844**	**420**	**1,278**	**14**
Anabæna,	0	0	0	0	0	0	60	38	6,800	324	1,200	4
Cœlosphærium,	0	0	0	0	0	0	0	2	36	24	60	8
Microcystis,	0	0	0	0	0	0	0	2	8	60	16	0
Algæ,	**218**	**360**	**312**	**654**	**380**	**358**	**19**	**42**	**32**	**324**	**126**	**104**
Dictyosphærium,	50	0	260	0	168	2	5	0	0	0	0	0
Protococcus,	76	360	0	636	0	0	9	18	16	32	64	30
Raphidium,	32	0	20	7	56	80	4	22	4	192	38	70
Scenedesmus,	60	0	32	11	156	272	1	0	0	0	4	4
Selenastrum,	0	0	0	0	0	0	0	0	0	0	16	0
Staurastrum,	0	0	0	0	0	4	0	0	12	28	4	0
Staurogenia,	0	0	0	0	0	0	0	2	0	72	0	0
ANIMALS.												
Rhizopoda,	**1**	**0**	**0**	**0**	**2**	**0**	**0**	**24**	**0**	**0**	**0**	**0**
Infusoria,	**98**	**778**	**58**	**38**	**53**	**1,222**	**0**	**26**	**6**	**108**	**12**	**0**
Cryptomonas,	0	0	0	0	2	10	0	0	0	0	0	0
Dinobryon,	7	364	21	28	32	1,200	0	0	0	0	0	0
Mallomonas,	0	4	1	0	0	0	0	20	0	0	2	0
Peridinium,	20	168	8	8	8	0	0	0	0	0	0	0
Raphidomonas,	56	172	20	0	2	12	0	0	0	0	0	0
Trachelomonas,	4	48	4	1	2	0	0	6	0	104	8	0
Uroglena,	5	10	0	0	0	0	0	0	0	0	0	0
Vermes,	**27**	**16**	**1**	**5**	**0**	**0**	**1**	**0**	**0**	**6**	**0**	**0**
Crustacea,	**0**	**0**	**0**	**0**	**pr.**	**0**	**0**	**pr.**	**0**	**0**	**pr.**	**pr.**
Miscellaneous, Zoöglœa,	**40**	**60**	**25**	**0**	**60**	**90**	**120**	**80**	**0**	**100**	**120**	**5**
TOTAL,	480	1,366	1,264	1,278	691	1,826	459	228	6,906	1,064	1,642	207

WATER SUPPLY OF WINTHROP.

(See *Revere*.)

WOBURN.

WATER SUPPLY OF WOBURN.

Chemical Examination of Water from the Filter-gallery of the Woburn Water Works.

[Parts per 100,000.]

Number.	Date of Collection.	Appearance.			Residue on Evaporation.	Ammonia.		Chlorine.	Nitrogen as		Oxygen Consumed.	Hardness.	Iron.
		Turbidity.	Sediment.	Color.		Free.	Albuminoid.		Nitrates.	Nitrites.			
	1897.												
18350	Jan. 25	None.	None.	.02	10.90	.0034	.0026	1.44	.0220	.0001	.08	4.7	.0000
18546	Feb. 18	None.	None.	.00	10.30	.0038	.0032	1.46	.0170	.0000	.03	4.4	.0000
18838	Mar. 23	None.	None.	.00	9.80	.0046	.0026	1.43	.0350	.0000	.03	4.9	.0000
19087	Apr. 21	None.	None.	.02	10.00	.0066	.0024	1.39	.0280	.0000	.06	4.9	.0000
19290	May 19	None.	None.	.00	9.50	.0002	.0068	1.36	.0270	.0000	.04	4.9	.0040
19493	June 16	None.	None.	.00	9.70	.0046	.0038	1.27	.0220	.0000	.04	4.7	.0030
19847	July 21	None.	None.	.00	9.90	.0036	.0026	1.31	.0120	.0000	.03	5.0	.0010
20143	Aug. 18	None.	None.	.00	10.10	.0052	.0040	1.31	.0140	.0000	.06	5.0	.0040
20608	Sept. 22	None.	None.	.00	10.40	.0050	.0030	1.31	.0100	.0000	.02	5.1	.0010
20910	Oct. 20	None.	None.	.02	10.00	.0046	.0022	1.32	.0220	.0000	.06	5.1	.0010
21282	Nov. 17	None.	V. slight.	.02	10.00	.0040	.0024	1.33	.0120	.0000	.05	5.9	.0010
21663	Dec. 22	V. slight.	V. slight.	.04	10.10	.0042	.0030	1.38	.0210	.0001	.03	5.3	.0000

Averages by Years.

-	1888	-	-	.00	12.00	.0012	.0032	2.50	.0346	.0000	-	-	-
-	1889	-	-	.00	10.84	.0010	.0022	2.07	.0372	.0000	-	-	-
-	1890	-	-	.01	11.06	.0012	.0023	1.91	.0481	.0000	-	5.0	-
-	1891	-	-	.00	10.85	.0008	.0015	1.79	.0668	.0000	-	4.9	-
-	1892	-	-	.00	11.27	.0012	.0024	1.95	.0542	.0000	-	5.1	-
-	1893	-	-	.00	11.50	.0022	.0018	2.04	.0447	.0000	.05	5.3	.0004
-	1894	-	-	.01	11.02	.0026	.0018	1.94	.0262	.0000	.05	5.0	.0021
-	1895	-	-	.01	10.82	.0031	.0022	1.74	.0204	.0000	.06	4.9	.0023
-	1896	-	-	.01	10.49	.0033	.0031	1.56	.0242	.0000	.04	5.0	.0011
-	1897	-	-	.01	10.06	.0041	.0032	1.36	.0202	.0000	.04	5.0	.0012

NOTE to analyses of 1897: Odor, none. A faintly unpleasant odor was developed in two of the samples, on heating. —— The samples were collected from the filter-gallery.

WOBURN.

Chemical Examination of Water from Horn Pond, Woburn.

[Parts per 100,000.]

Number.	Date of Collection.	Appearance.			Residue on Evaporation.		Ammonia.				Chlorine.	Nitrogen as		Oxygen Consumed.	Hardness.
								Albuminoid.							
		Turbidity.	Sediment.	Color.	Total.	Loss on Ignition.	Free.	Total.	Dissolved.	Suspended.		Nitrates.	Nitrites.		
	1897.														
18349	Jan. 25	Slight.	V. slight.	.40	9.25	3.45	.0070	.0350	.0300	.0050	1.00	.0750	.0005	.49	2.7
18545	Feb. 18	V. slight.	V. slight	.35	8.45	2.90	.0070	.0264	.0202	.0062	1.15	.0600	.0005	.41	3.0
18837	Mar. 23	Slight.	Slight.	.40	7.20	2.20	.0096	.0300	.0192	.0108	1.02	.0700	.0027	.40	2.9
19086	Apr. 21	Distinct.	Cons.	.55	6.75	1.95	.0036	.0312	.0178	.0134	0.89	.0600	.0011	.46	2.7
19289	May 19	Slight.	Cons.	.42	7.05	2.05	.0006	.0304	.0212	.0092	0.95	.0400	.0012	.56	2.7
19492	June 16	Distinct.	Slight.	.44	7.65	2.30	.0066	.0316	.0202	.0114	0.78	.0400	.0005	.59	3.0
19846	July 21	Distinct.	Cons., green.	.40	8.85	2.80	.0030	.0510	.0254	.0256	1.05	.0400	.0018	.58	3.4
20142	Aug. 18	Distinct.	Slight.	.32	7.90	1.90	.0018	.0538	.0260	.0278	1.05	.0030	.0000	.47	3.2
20607	Sept. 22	Slight.	Cons.	.38	8.20	2.05	.0016	.0360	.0226	.0134	1.05	.0000	.0000	.42	3.6
20909	Oct. 20	Slight.	Slight.	.42	8.15	1.95	.0076	.0408	.0210	.0198	1.04	.0230	.0002	.48	3.5
21281	Nov. 17	Slight.	Cons.	.35	7.90	2.20	.0106	.0298	.0236	.0062	1.11	.0180	.0007	.40	4.0
21662	Dec. 22	Slight.	Cons.	.47	8.00	1.90	.0032	.0302	.0222	.0080	1.13	.0380	.0005	.48	3.5

Averages by Years.

-	1888	-	-	.32	11.28	1.71	.0186	.0383	-	-	2.98	.0398	.0015	-	-
-	1889	-	-	.30	8.37	2.03	.0092	.0376	.0216	.0160	1.98	.0498	.0015	-	-
-	1890	-	-	.27	10.76	2.07	.0080	.0380	.0211	.0169	1.93	.0542	.0008	-	3.4
-	1891	-	-	.22	8.90	2.06	.0129	.0453	.0237	.0216	1.76	.0502	.0009	-	2.9
-	1892	-	-	.25	10.57	2.13	.0110	.0358	.0216	.0142	2.42	.0821	.0008	-	3.3
-	1893	-	-	.30	9.83	2.51	.0061	.0455	.0247	.0208	2.10	.0472	.0009	.45	3.2
-	1894	-	-	.33	9.03	1.98	.0065	.0292	.0184	.0108	1.84	.0404	.0009	.40	3.3
-	1895	-	-	.36	9.43	2.84	.0087	.0297	.0205	.0092	1.53	.0523	.0014	.48	3.4
-	1896	-	-	.27	8.27	2.43	.0043	.0321	.0199	.0122	1.18	.0476	.0010	.39	3.1
-	1897	-	-	.41	7.95	2.30	.0052	.0355	.0224	.0131	1.02	.0389	.0008	.48	3.2

NOTE to analyses of 1897: Odor, generally distinctly vegetable, and occasionally mouldy and grassy. —— The samples were collected from the pond, at its outlet, 1 foot beneath the surface.

WOBURN.

Microscopical Examination of Water from Horn Pond, Woburn.

[Number of organisms per cubic centimeter.]

	1897.											
	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
Day of examination,	29	20	25	22	20	19	23	19	23	22	18	28
Number of sample,	18349	18545	18837	19086	19289	19492	19846	20142	20607	20909	21281	21662
PLANTS.												
Diatomaceæ,	**244**	**248**	**611**	**4,865**	**15,440**	**50**	**1,224**	**72**	**508**	**288**	**1,174**	**1,236**
Asterionella,	236	240	576	4,516	0	0	0	0	0	156	736	8
Fragilaria,	0	0	12	0	0	0	0	70	320	32	62	47
Melosira,	0	8	12	20	0	0	0	0	80	20	0	26
Synedra,	8	0	8	320	1,840	50	1,224	2	72	80	376	1,152
Tabellaria,	0	0	3	9	13,600	0	0	0	0	0	0	2
Cyanophyceæ,	**0**	**0**	**0**	**0**	**26**	**326**	**544**	**188**	**200**	**128**	**19**	**0**
Anabæna,	0	0	0	0	22	320	408	124	52	108	18	0
Clathrocystis,	0	0	0	0	4	0	24	8	0	0	0	0
Cœlosphærium,	0	0	0	0	0	6	112	56	148	20	1	0
Algæ,	**20**	**1**	**12**	**17**	**32**	**446**	**962**	**166**	**178**	**122**	**138**	**35**
Cosmarium,	0	0	4	0	4	68	0	84	10	60	1	0
Protococcus,	20	0	8	15	0	112	28	48	96	0	37	5
Raphidium,	0	0	0	0	0	152	0	0	0	16	2	2
Scenedesmus,	0	1	0	0	24	60	800	26	60	36	92	28
Staurastrum,	0	0	0	2	2	0	132	8	4	4	1	0
ANIMALS.												
Rhizopoda, Arcella,	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**2**	**0**	**0**
Infusoria,	**2**	**18**	**21**	**9**	**88**	**10**	**14**	**2**	**14**	**48**	**135**	**7**
Cryptomonas,	0	3	0	0	84	0	0	0	0	0	0	0
Trachelomonas,	2	10	9	6	2	0	6	0	10	48	120	6
Zoöthamnium,	0	0	0	0	0	10	0	0	0	0	0	0
Vermes,	**0**	**1**	**1**	**1**	**0**	**0**	**8**	**2**	**0**	**0**	**0**	**0**
Crustacea,	**0**	**0**	**0**	**0**	**pr.**	**0**	**pr.**	**pr.**	**pr.**	**pr.**	**0**	**0**
Miscellaneous, Zoögicœa,	**120**	**0**	**120**	**0**	**90**	**15**	**40**	**20**	**20**	**10**	**25**	**10**
TOTAL,	386	268	765	4,892	15,676	847	2,792	450	920	598	1,491	1,288

WATER SUPPLY OF WORCESTER.

LEICESTER SUPPLY.— *Chemical Examination of Water from Lynde Brook Storage Reservoir.*

[Parts per 100,000.]

Number.	Date of Collection.	Appearance.			Residue on Evaporation.		Ammonia.				Chlorine.	Nitrogen as		Oxygen Consumed.	Hardness.
		Turbidity.	Sediment.	Color.	Total.	Loss on Ignition.	Free.	Albuminoid. Total.	Albuminoid. Dissolved.	Albuminoid. Suspended.		Nitrates.	Nitrites.		
	1897.														
18283	Jan. 18	Distinct, clayey.	Cons., sandy.	.40	3.55	0.80	.0094	.0108	.0106	.0002	.21	.0070	.0002	.44	0.9
18517	Feb. 16	Slight.	V. slight.	.30	3.00	0.95	.0018	.0156	.0138	.0018	.21	.0150	.0000	.33	0.6
18784	Mar. 15	Slight.	V. slight.	.35	3.25	0.95	.0030	.0138	.0124	.0014	.22	.0120	.0001	.35	0.6
19076	Apr. 20	Slight.	Cons.	.30	2.65	0.95	.0018	.0164	.0138	.0026	.10	.0100	.0001	.37	0.5
19272	May 18	V. slight.	V. slight.	.28	2.50	0.80	.0008	.0170	.0152	.0018	.17	.0030	.0000	.30	0.6
19473	June 15	V. slight.	V. slight.	.25	3.35	1.05	.0022	.0254	.0168	.0086	.10	.0090	.0001	.37	0.6
19839	July 20	V. slight.	V. slight.	.36	2.95	1.20	.0036	.0174	.0166	.0008	.19	.0000	.0000	.42	0.8
20129	Aug. 17	None.	V. slight.	.44	3.50	1.35	.0036	.0188	.0158	.0030	.16	.0020	.0000	.50	0.6
20589	Sept. 21	V. slight.	V. slight.	.90	4.40	2.25	.0224	.0268	.0238	.0030	.16	.0030	.0000	.47	1.1
20890	Oct. 19	Slight.	V. slight.	.60	3.30	1.65	.0138	.0190	.0170	.0020	.16	.0230	.0000	.44	1.0
21252	Nov. 16	Decided.	Cons.	.50	3.65	1.50	.0120	.0266	.0228	.0038	.22	.0080	.0001	.53	1.0
21651	Dec. 23	Decided.	Heavy.	.63	3.60	1.50	.0074	.0214	.0186	.0028	.23	.0120	.0001	.47	1.1

Averages by Years.

-	1888	-	-	.24	2.64	0.85	.0037	.0151	-	-	.14	.0065	.0001	-	-
-	1889	-	-	.24	2.54	0.60	.0030	.0167	.0138	.0029	.15	.0053	.0001	-	-
-	1890	-	-	.21	3.07	1.15	.0026	.0132	.0107	.0025	.14	.0078	.0001	-	0.9
-	1891	-	-	.24	2.83	1.03	.0045	.0126	.0101	.0025	.12	.0074	.0001	-	0.7
-	1892	-	-	.25	2.99	1.15	.0038	.0139	.0113	.0026	.15	.0105	.0000	-	0.8
-	1893	-	-	.26	2.66	0.98	.0036	.0162	.0122	.0039	.15	.0066	.0001	.35	0.6
-	1894	-	-	.36	3.37	1.09	.0055	.0139	.0117	.0022	.18	.0103	.0000	.35	1.2
-	1895	-	-	.32	3.63	1.30	.0033	.0161	.0138	.0023	.20	.0116	.0000	.45	1.2
-	1896	-	-	.29	2.95	1.27	.0035	.0158	.0133	.0025	.18	.0054	.0000	.38	0.8
-	1897	-	-	.44	3.31	1.25	.0068	.0191	.0164	.0027	.18	.0087	.0001	.42	0.8

NOTE to analyses of 1897: Odor, generally distinctly vegetable; of the last sample, none, becoming faintly musty on heating. —— The samples were collected from the reservoir, near the gate-house, about 1 foot beneath the surface.

For monthly record of heights of water in this reservoir, see page 350.

WORCESTER.

LEICESTER SUPPLY.—*Microscopical Examination of Water from Lynde Brook Storage Reservoir.*

[Number of organisms per cubic centimeter.]

	1897. Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
Day of examination,	20	19	17	22	19	16	22	18	22	21	17	24
Number of sample,	18283	18517	18784	19076	19272	19473	19839	20129	20589	20890	21252	21651
PLANTS.												
Diatomaceæ,	4	0	0	22	19	9	0	12	104	82	50	1
Melosira,	0	0	0	8	0	0	0	8	70	60	0	0
Cyanophyceæ,	0	0	0	0	0	280	0	0	0	12	0	0
Anabæna,	0	0	0	0	0	280	0	0	0	4	0	0
Algæ,	4	0	0	0	10	216	15	3	2	10	8	0
Staurogenia,	0	0	0	0	0	216	0	3	0	0	0	0
ANIMALS.												
Rhizopoda, Actinophrys,	0	0	0	0	0	0	0	1	0	0	0	0
Infusoria,	1	6	8	1	8	0	0	1,165	82	166	4	4
Dinobryon,	0	0	1	0	5	0	0	1,160	76	160	0	0
Vermes,	0	0	0	0	0	0	0	0	0	0	0	2
Miscellaneous, Zoöglœa,	3	50	10	20	0	40	5	15	3	15	25	100
TOTAL,	12	56	18	43	37	545	20	1,196	191	285	87	106

LEICESTER SUPPLY.—*Chemical Examination of Water from Kent Reservoir on Kettle Brook in Leicester.*

[Parts per 100,000.]

Number.	Date of Collection.	Appearance. Turbidity.	Appearance. Sediment.	Appearance. Color.	Residue on Evaporation. Total.	Residue on Evaporation. Loss on Ignition.	Ammonia. Free.	Ammonia. Albuminoid. Total.	Ammonia. Albuminoid. Dissolved.	Ammonia. Albuminoid. Suspended.	Chlorine.	Nitrogen as Nitrates.	Nitrogen as Nitrites.	Oxygen Consumed.	Hardness.
	1897.														
18285	Jan. 18	Slight.	V. slight.	.30	4.20	1.35	.0014	.0102	.0102	.0000	.21	.0150	.0002	.32	1.1
18785	Mar. 15	V. slight.	Slight.	.37	3.05	1.05	.0020	.0148	.0138	.0010	.26	.0120	.0000	.42	0.6
19077	Apr. 20	V. slight.	V. slight.	.33	2.45	0.80	.0006	.0160	.0130	.0030	.14	.0070	.0001	.44	0.6
Av...	....	....	....	.33	3.23	1.07	.0013	.0137	.0123	.0014	.20	.0113	.0001	.39	0.8

Odor, distinctly vegetable.——The samples were collected from the reservoir at the gate-house, 1 foot beneath the surface.

Microscopical Examination.

No. 18285. Diatomaceæ, *Asterionella*, 2. Infusoria, *Dinobryon*, 2; *Peridinium*, 1. Miscellaneous, *Zoöglœa*, 10. Total, 15.

No. 18785. Diatomaceæ, *Eunotia*, 1; *Melosira*, 8; *Nitzschia*, 1; *Synedra*, 2; *Tabellaria*, 29. Infusoria, *Dinobryon*, 15; *Monas*, 1; *Peridinium*, 1. Total, 58.

No. 19077. Diatomaceæ, *Asterionella*, 14; *Melosira*, 22; *Meridion*, 2; *Pinnularia*, 1; *Surirella*, 1; *Synedra*, 28; *Tabellaria*, 27. Algæ, *Raphidium*, 1. Infusoria, *Cryptomonas*, 1; *Dinobryon*, 5; *Mallomonas*, 1; *Peridinium*, 3; *Raphidomonas*, 2. Vermes, *Rotatorian ova*, 1. Miscellaneous, *Zoöglœa*, 20. Total, 129.

WORCESTER.

LEICESTER SUPPLY. — *Chemical Examination of Water from Mann Reservoir on Kettle Brook, Leicester.*

[Parts per 100,000.]

Number.	Date of Collection.	Appearance.			Residue on Evaporation.		Ammonia.				Chlorine.	Nitrogen as		Oxygen Consumed.	Hardness.
		Turbidity.	Sediment.	Color.	Total.	Loss on Ignition.	Free.	Albuminoid. Total.	Albuminoid. Dissolved.	Albuminoid. Sus-pended.		Nitrates.	Nitrites.		
	1897.														
18519	Feb. 16	V. slight.	V. slight.	.33	3.50	1.05	.0032	.0108	.0096	.0012	.18	.0180	.0000	.35	0.9
18782	Mar. 15	V. slight.	Slight.	.42	3.30	1.35	.0016	.0136	.0130	.0006	.22	.0120	.0000	.48	0.6
19271	May 18	Slight.	V. slight.	.38	2.55	1.15	.0008	.0240	.0172	.0068	.14	.0030	.0001	.45	0.5
19476	June 15	V. slight.	V. slight.	.41	3.40	1.50	.0012	.0206	.0146	.0060	.09	.0100	.0000	.54	0.6
19838	July 20	V. slight.	V. slight.	.47	3.05	1.35	.0020	.0220	.0192	.0028	.14	.0030	.0000	.59	1.0
20131	Aug. 17	V. slight.	V. slight.	.42	3.20	1.50	.0012	.0202	.0152	.0050	.14	.0020	.0000	.54	0.8
20590	Sept. 21	Slight.	Slight.	.42	3.30	1.65	.0008	.0240	.0188	.0052	.15	.0000	.0000	.50	0.8
20889	Oct. 19	V. slight.	Slight.	.40	3.00	1.40	.0002	.0212	.0170	.0042	.15	.0020	.0000	.50	1.0
21251	Nov. 16	V. slight.	Slight.	.41	3.30	1.70	.0020	.0214	.0182	.0032	.23	.0050	.0001	.52	1.1
21650	Dec. 23	Slight.	Slight.	.43	3.65	1.45	.0014	.0176	.0158	.0018	.25	.0160	.0000	.46	1.7

Averages by Years.

–	1895	–	–	.50	3.56	1.67	.0054	.0234	.0187	.0047	.18	.0087	.0000	.60	1.0
–	1896	–	–	.36	3.15	1.39	.0041	.0203	.0161	.0042	.14	.0078	.0000	.50	0.9
–	1897	–	–	.41	3.22	1.41	.0014	.0195	.0158	.0037	.17	.0071	.0000	.49	0.9

NOTE to analyses of 1897: Odor, vegetable and occasionally unpleasant. —— The samples were collected from the reservoir, near the dam, 1 foot beneath the surface.

LEICESTER SUPPLY. — *Microscopical Examination of Water from Mann Reservoir on Kettle Brook, Leicester.*

[Number of organisms per cubic centimeter.]

	1897. Feb.	Mar.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
Day of examination,	19	17	19	18	22	18	23	21	17	24
Number of sample,	18519	18782	19271	19476	19838	20131	20590	20889	21251	21650
PLANTS.										
Diatomaceæ,	**0**	**4**	**368**	**156**	**84**	**262**	**1,174**	**300**	**228**	**3**
Asterionella,	0	0	0	0	0	16	68	46	128	2
Melosira,	0	0	176	82	56	198	1,060	156	16	0
Synedra,	0	4	184	28	10	8	8	40	52	1
Cyanophyceæ, Anabæna,	**0**	**0**	**0**	**0**	**0**	**44**	**0**	**0**	**0**	**0**
Algæ,	**0**	**0**	**1**	**68**	**2**	**0**	**20**	**62**	**34**	**0**
Raphidium,	0	0	0	52	0	0	0	28	8	0

WORCESTER.

LEICESTER SUPPLY. — *Microscopical Examination of Water from Mann Reservoir on Kettle Brook, Leicester* — Concluded.

[Number of organisms per cubic centimeter.]

	1897.									
	Feb.	Mar.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
ANIMALS.										
Infusoria,	3	10	38	4	96	54	198	370	80	1
Dinobryon,	1	10	0	0	96	50	184	364	76	0
Peridinium,	0	0	36	2	0	2	0	2	0	1
Vermes,	1	0	0	0	3	2	0	4	2	0
Crustacea, Bosmina,	0	0	0	0	0	0	0	0	pr.	0
Miscellaneous, Zoöglœa,	35	0	50	70	45	25	10	20	15	5
TOTAL,	39	14	457	298	230	387	1,402	756	359	9

LEICESTER SUPPLY. — *Chemical Examination of Water from Bottomly Pond on Kettle Brook, Paxton.*

[Parts per 100,000.]

Number.	Date of Collection.	Appearance.			Residue on Evaporation.		Ammonia.				Chlorine.	Nitrogen as		Oxygen Consumed.	Hardness.
								Albuminoid.							
		Turbidity.	Sediment.	Color.	Total.	Loss on Ignition.	Free.	Total.	Dissolved.	Sus-pended.		Nitrates.	Nitrites.		
	1897.														
18284	Jan. 18	V. slight.	V. slight.	.35	4.15	1.55	.0018	.0144	.0144	.0000	.21	.0080	.0002	.53	1.1
18518	Feb. 16	Slight.	Slight.	.40	4.65	1.50	.0064	.0318	.0184	.0134	.44	.0150	.0000	.55	1.3
18783	Mar. 15	Slight.	Slight.	.40	3.25	1.10	.0020	.0202	.0142	.0060	.21	.0150	.0000	.45	0.5
19075	Apr. 20	Slight.	Cons.	.40	2.25	1.30	.0014	.0230	.0160	.0070	.14	.0070	.0001	.50	0.5
19270	May 18	V. slight.	V. slight.	.38	2.25	0.85	.0000	.0232	.0184	.0048	.16	.0030	.0000	.43	0.8
19475	June 15	V. slight.	V. slight.	.34	3.30	1.15	.0006	.0194	.0160	.0034	.08	.0060	.0000	.51	0.6
19840	July 20	V. slight.	V. slight.	.40	2.80	1.25	.0008	.0224	.0168	.0056	.13	.0000	.0000	.57	0.8
20132	Aug. 17	V. slight.	V. slight.	.43	3.40	1.55	.0012	.0230	.0184	.0046	.12	.0020	.0000	.61	0.8
20591	Sept. 21	Slight.	Cons.	.45	3.05	1.60	.0010	.0382	.0214	.0168	.12	.0020	.0000	.56	0.6
20891	Oct. 19	V. slight.	Slight.	.40	2.95	1.60	.0002	.0208	.0186	.0022	.16	.0030	.0001	.47	1.1
21253	Nov. 16	V. slight.	Cons.	.40	2.80	1.45	.0016	.0270	.0212	.0058	.16	.0030	.0002	.48	0.8
21652	Dec. 23	Slight.	Cons.	.63	3.50	1.50	.0042	.0228	.0208	.0020	.19	.0120	.0000	.54	1.6

Averages by Years.

–	1895	–	–	.46	3.51	1.84	.0056	.0259	.0223	.0036	.17	.0057	.0001	.64	1.0
–	1896	–	–	.37	2.89	1.43	.0042	.0199	.0168	.0031	.14	.0070	.0000	.50	0.7
–	1897	–	–	.41	3.20	1.37	.0018	.0239	.0179	.0060	.18	.0063	.0000	.52	0.9

NOTE to analyses of 1897: Odor, generally faintly vegetable, occasionally musty. On heating, a fishy odor was developed in the May and June samples. —— The samples were collected from the reservoir, near the dam, 1 foot beneath the surface.

WORCESTER.

LEICESTER SUPPLY.—*Microscopical Examination of Water from Bottomly Pond on Kettle Brook, Paxton.*

[Number of organisms per cubic centimeter.]

	1897.											
	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept	Oct.	Nov.	Dec.
Day of examination,	20	19	17	21	19	18	22	18	23	21	17	24
Number of sample,	18284	18518	18783	19075	19270	19475	19840	20132	20591	20891	21253	21652
PLANTS.												
Diatomaceæ,	1	1	0	24	141	37	61	262	204	144	369	34
Asterionella,	1	0	0	0	17	0	0	0	16	24	53	27
Cyclotella,	0	0	0	0	0	32	60	256	42	60	52	2
Synedra,	0	1	0	6	112	4	0	5	44	22	256	5
Cyanophyceæ, Merismopœdia,	0	0	0	0	0	0	0	0	0	8	4	0
Algæ,	0	0	0	0	0	6	1	26	16	48	6	0
ANIMALS.												
Rhizopoda, Arcella,	0	0	0	0	0	0	0	0	4	0	0	0
Infusoria,	1	0	416	18	42	268	2	6	14	0	23	3
Dinobryon,	1	0	416	0	0	0	0	0	0	0	21	1
Peridinium,	0	0	0	4	40	268	1	4	0	0	0	2
Vermes,	0	1	2	0	0	1	3	1	2	0	2	1
Crustacea, Cyclops,	0	0	0	0	0	pr.	0	0	pr.	0	0	0
Miscellaneous, Zoögiœa,	0	0	0	40	15	60	20	10	20	5	10	5
TOTAL,	2	2	418	82	198	372	87	305	260	205	414	43

WORCESTER.

HOLDEN SUPPLY. — *Chemical Examination of Water from Tatnuck Brook Storage Reservoir.*

[Parts per 100,000.]

Number.	Date of Collection.	Appearance. Turbidity.	Appearance. Sediment.	Appearance. Color.	Residue on Evaporation. Total.	Residue on Evaporation. Loss on Ignition.	Ammonia. Free.	Ammonia. Albuminoid. Total.	Ammonia. Albuminoid. Dissolved.	Ammonia. Albuminoid. Suspended.	Chlorine.	Nitrogen as Nitrates.	Nitrogen as Nitrites.	Oxygen Consumed.	Hardness.
	1897.														
18282	Jan. 18	Slight.	Slight.	.20	2.45	0.75	.0008	.0126	.0100	.0026	.18	.0030	.0002	.34	0.5
18516	Feb. 16	V. slight.	V. slight.	.28	2.25	0.75	.0016	.0152	.0098	.0054	.20	.0070	.0000	.30	0.6
18781	Mar. 15	V. slight.	Slight.	.25	2.25	0.60	.0002	.0114	.0092	.0022	.20	.0060	.0000	.31	0.3
19074	Apr. 20	Slight.	Slight.	.20	1.75	0.50	.0008	.0122	.0108	.0014	.15	.0030	.0001	.26	0.6
19269	May 18	V. slight.	V. slight.	.18	1.45	0.45	.0000	.0158	.0108	.0050	.14	.0000	.0000	.30	0.2
19474	June 15	None.	V. slight.	.23	2.40	0.85	.0000	.0134	.0106	.0028	.09	.0050	.0000	.30	0.2
19837	July 20	V. slight.	V. slight.	.19	1.90	0.65	.0022	.0182	.0154	.0028	.16	.0000	.0000	.30	0.5
20130	Aug. 17	V. slight.	V. slight.	.15	2.00	0.90	.0010	.0144	.0118	.0026	.15	.0020	.0000	.32	0.5
20588	Sept. 21	V. slight.	Slight.	.18	2.15	1.10	.0004	.0186	.0150	.0036	.14	.0000	.0000	.30	0.3
20888	Oct. 19	V. slight.	V. slight.	.20	2.00	1.00	.0006	.0190	.0172	.0018	.15	.0300	.0000	.24	0.3
21250	Nov. 16	V. slight.	Cons.	.18	2.35	1.20	.0004	.0190	.0156	.0034	.18	.0030	.0000	.30	0.8
21649	Dec. 23	V. slight.	Cons.	.30	2.55	1.15	.0010	.0160	.0138	.0022	.22	.0060	.0000	.32	1.3

Averages by Years.

-	1888	-	-	.17	2.23	0.75	.0012	.0157	-	-	.12	.0043	.0001	-	-
-	1889	-	-	.19	2.04	0.57	.0003	.0143	.0112	.0031	.12	.0031	.0001	-	-
-	1890	-	-	.17	2.68	1.24	.0007	.0141	.0102	.0039	.13	.0078	.0001	-	0.9
-	1891	-	-	.17	2.30	0.94	.0024	.0143	.0102	.0041	.11	.0077	.0001	-	0.4
-	1892	-	-	.20	2.52	1.03	.0012	.0142	.0113	.0029	.12	.0067	.0000	-	0.5
-	1893	-	-	.35	2.45	0.93	.0020	.0182	.0140	.0042	.14	.0049	.0000	.36	0.5
-	1894	-	-	.20	2.27	0.85	.0010	.0151	.0114	.0037	.16	.0032	.0000	.30	0.4
-	1895	-	-	.21	2.33	0.98	.0012	.0173	.0130	.0043	.18	.0068	.0000	.36	0.5
-	1896	-	-	.17	2.00	0.84	.0008	.0142	.0109	.0033	.15	.0034	.0000	.27	0.4
-	1897	-	-	.21	2.12	0.82	.0007	.0155	.0125	.0030	.16	.0054	.0000	.30	0.5

NOTE to analyses of 1897: Odor, generally faintly vegetable, becoming frequently stronger, and in February and May also fishy on heating. —— The samples were collected from the reservoir, at the gate-house, 1 foot beneath the surface. For monthly record of height of water in this reservoir, see page 350.

WORCESTER.

HOLDEN SUPPLY. — *Microscopical Examination of Water from Tatnuck Brook Storage Reservoir.*

[Number of organisms per cubic centimeter.]

	1897.											
	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov	Dec.
Day of examination,	20	19	17	21	19	18	22	18	22	21	17	24
Number of sample,	18282	18516	18781	19074	19269	19474	19837	20130	20588	20888	21250	21649
PLANTS.												
Diatomaceæ,	78	0	0	272	584	460	28	424	342	484	298	167
Asterionella,	32	0	0	8	36	88	14	252	96	84	58	16
Cyclotella,	0	0	0	0	0	0	0	2	104	6	4	0
Fragilaria,	0	0	0	0	100	0	0	8	8	14	0	0
Melosira,	12	0	0	126	166	78	5	28	106	316	120	119
Synedra,	0	0	0	6	6	1	1	10	26	18	56	24
Tabellaria,	34	0	0	132	276	292	8	124	0	44	60	3
Cyanophyceæ,	0	0	0	0	0	0	0	16	0	6	0	0
Anabæna,	0	0	0	0	0	0	0	10	0	0	0	0
Algæ,	6	32	1	0	18	2	1	10	26	136	170	13
Protococcus,	0	0	1	0	8	0	0	0	6	14	148	13
Raphidium,	6	0	0	0	0	0	0	8	12	116	16	0
ANIMALS.												
Rhizopoda,	0	0	0	0	0	0	1	0	2	0	0	0
Infusoria,	18	970	123	120	481	0	10	12	14	6	12	5
Dinobryon,	17	968	120	120	480	0	0	0	0	0	8	0
Uroglena,	0	0	0	0	1	0	0	0	0	0	0	0
Vermes,	1	1	1	0	0	1	1	0	2	4	2	1
Crustacea,	0	0	0	0	0	pr.	pr.	0	pr.	pr.	0	0
Miscellaneous, Zoöglœa,	10	0	0	40	35	40	30	15	20	25	5	5
TOTAL,	113	1,003	125	432	1,118	503	71	477	406	661	487	191

WORCESTER.

Record of Height of Water in Leicester and Holden Storage Reservoirs on the First of Each Month in 1897.

NOTE.—Leicester Reservoir, height of rollway, 37.40 feet; Holden Reservoir, height of rollway, 30.10 feet.

DATE.	HEIGHT OF WATER.		DATE.	HEIGHT OF WATER.	
	Leicester.	Holden.		Leicester.	Holden.
1897.	Feet.	Feet.	1897.	Feet.	Feet.
Jan. 1, ...	23.20	29.30	July 1, ...	29.55	29.93
Feb. 1, ...	24.75	30.10	Aug. 1, ...	19.55	30.18
Mar. 1, ...	27.75	30.10	Sept. 1, ...	15.05	29.69
April 1, ...	37.92	30.25	Oct. 1, ...	13.65	27.20
May 1, ...	37.45	30.13	Nov. 1, ...	19.65	25.00
June 1, ...	37.40	30.13	Dec. 1, ...	22.85	26.10

EXAMINATION OF RIVERS.

[351]

EXAMINATION OF RIVERS.

During the year 1897 regular monthly examinations were made of the waters of the Blackstone, Charles, Hoosac, Housatonic, Merrimack, Nashua, Neponset, Saugus and Ware rivers, and occasional examinations of other rivers in the State. Nearly all of the results of these examinations will be found arranged alphabetically by rivers in the pages which follow, but some of them are given on preceding pages, in connection with the examinations of water supplies, under the names of the towns where the samples were collected, as follows: —

	Page
Charles at Brookline,	141
Charles at Newton,	254
Charles at Waltham,	317
Merrimack at Lawrence,	201
Merrimack at Lowell,	212
Neponset at Hyde Park,	197
Saugus at Saugus,	224

Blackstone River.

The regular monthly examinations of the waters of the Blackstone River have been continued as in previous years, and the results are given in the tables which follow.

The first of the tables is taken from the report of the superintendent of sewers of the city of Worcester for the year ending Nov. 30, 1897, and contains the monthly averages of analyses made by the city of samples of sewage and effluent collected at the Worcester Precipitation Works and the percentage of matters removed from the sewage by treatment at these works.

According to the above-mentioned report, there were treated during the year ending Nov. 30, 1897, an average of about 17,000,000 gallons per day of mingled sewage and brook water taken from the Mill Brook channel, and about 1,130 pounds of quick-lime were used for each million gallons of sewage treated. The effluent from the Precipitation Works and the excess of flow of Mill Brook over the amount treated was discharged into the Blackstone River.

BLACKSTONE RIVER.

Worcester Sewage Purification Works.

Abstract of Analyses of Sewage and Effluent made by the City of Worcester.

[Taken from the annual report of the superintendent of sewers of the city of Worcester for the year ending Nov. 30, 1897.]

[Parts per 100,000.]

DATE OF COLLECTION.	Ammonia.				Oxygen Consumed.		
		Albuminoid.					
	Free.	Total.	Dissolved.	Suspended.	Unfiltered.	Filtered.	Chlorine.
Sewage, December, 1896,	1.027	.483	.236	.247	4.20	2.22	6.07
Effluent, December, 1896,	.879	.260	.245	.015	2.20	2.20	6.09
Per cent. removed,	14.42	46.17	—3.81	93.93	47.62	0.91	—0.33
Sewage, January, 1897,	1.061	.472	.235	.237	3.85	2.22	5.82
Effluent, January, 1897,	.931	.259	.224	.035	2.19	2.19	5.87
Per cent. removed,	12.26	45.13	4.68	85.25	43.11	1.35	—0.86
Sewage, February, 1897,	.969	.445	.243	.202	4.61	2.49	5.71
Effluent, February, 1897.	.853	.229	.221	.008	2.26	2.26	5.77
Per cent. removed,	11.69	48.54	9.01	95.04	50.87	9.24	—1.05
Sewage, March, 1897,	.505	.256	.149	.107	3.03	1.79	3.60
Effluent, March, 1897,	.471	.132	.126	.006	1.53	1.53	3.75
Per cent. removed,	6.73	48.44	15.44	93.44	49.51	14.52	—4.26
Sewage, April, 1897,	.796	.321	.171	.150	3.51	1.99	4.62
Effluent, April, 1897,	.694	.179	.169	.010	2.00	2.00	4.64
Per cent. removed,	12.81	44.24	1.17	93.33	43.02	—0.50	—0.43
Sewage, May, 1897,	1.077	.428	.196	.232	3.96	1.81	5.64
Effluent, May, 1897,	.915	.202	.181	.021	1.90	1.90	5.70
Per cent. removed,	15.04	52.81	7.65	90.95	52.02	—4.97	—1.06
Sewage, June, 1897,	1.220	.491	.229	.262	4.31	2.05	6.23
Effluent, June, 1897,	1.089	.215	.198	.017	1.94	1.94	6.27
Per cent. removed,	9.10	56.20	13.54	93.53	54.98	5.37	—0.64
Sewage, July, 1897,	1.208	.486	.227	.259	3.75	1.71	6.39
Effluent, July, 1897,	1.095	.206	.189	.017	1.58	1.58	6.38
Per cent. removed,	9.35	57.62	16.67	93.34	57.88	7.02	0.16

BLACKSTONE RIVER.

WORCESTER SEWAGE PURIFICATION WORKS — *Concluded.*

[Parts per 100,000.]

DATE OF COLLECTION.	Ammonia.				Oxygen Consumed.		Chlorine.
	Free.	Albuminoid.			Unfiltered.	Filtered.	
		Total.	Dissolved.	Suspended.			
Sewage, August, 1897,	1.137	.648	.306	.342	4.40	1.75	6.59
Effluent, August, 1897,	1.063	.261	.248	.013	1.72	1.72	6.54
Per cent. removed,	6.50	59.71	18.95	96.20	60.89	1.72	0.76
Sewage, September, 1897,	1.457	.588	.308	.280	4.75	2.19	7.09
Effluent, September, 1897,	1.399	.263	.245	.018	1.92	1.92	7.07
Per cent. removed,	3.98	55.27	20.45	93.57	59.58	12.33	0.30
Sewage, October, 1897,	1.724	.621	.279	.342	5.57	2.78	6.84
Effluent, October, 1897,	1.583	.252	.241	.011	2.65	2.65	6.83
Per cent. removed,	8.18	59.42	13.62	96.79	52.42	4.67	0.15
Sewage, November, 1897,	1.108	.491	.224	.267	4.89	2.46	5.88
Effluent, November, 1897,	1.000	.225	.201	.024	2.44	2.44	5.79
Per cent. removed,	9.75	54.18	10.27	90.00	50.10	0.82	1.53
Sewage for year ending Dec. 1, 1897,	1.108	.478	.233	.245	4.23	2.12	5.87
Effluent for year ending Dec. 1, 1897,	1.001	.224	.208	.016	2.03	2.03	5.89
Per cent. removed,	9.66	53.02	10.75	93.46	52.00	4.25	−0.34

NOTE. — Monthly averages are made from daily analyses of sewage and effluent. The daily sewage samples consist of forty-eight portions taken half hourly. Sewage samples are taken as nearly as possible in proportion to the amount of sewage being received at the time of sampling. Effluent samples consist of twenty-four portions taken hourly.

BLACKSTONE RIVER.

Averages of Chemical Analyses of Water from the Blackstone River for the Years 1888 to 1897, inclusive.

Blackstone River between Mill Brook Channel and the Sewage Precipitation Works.

[Parts per 100,000.]

Year.	Color.	Residue on Evaporation. Total.	Residue on Evaporation. Loss on Ignition.	Ammonia. Free.	Ammonia. Albuminoid. Total.	Ammonia. Albuminoid. Dissolved.	Ammonia. Albuminoid. Suspended.	Chlorine.	Nitrogen as Nitrates.	Nitrogen as Nitrites.	Hardness.
1888, ...	0.64	–	–	.2112	.1040	–	–	1.21	.0370	.0029	–
1889, ...	0.76	–	–	.2841	.1198	.0629	.0569	1.06	.0235	.0024	–
1890, ...	0.82	–	–	.1800	.1024	.0549	.0475	1.03	.0367	.0014	–
1891, ...	0.80	13.54	4.00	.3340	.1563	.0840	.0723	1.73	.0333	.0032	4.6
1892, ...	0.71	16.28	4.85	.2530	.1262	.0627	.0635	1.84	.0312	.0061	4.9
1893, ...	0.68	17.95	4.88	.1429	.0603	.0325	.0277	1.04	.0180	.0012	4.5
1894, ...	0.86	17.17	5.58	.0739	.0570	.0304	.0266	0.88	.0195	.0006	3.7
1895, ...	0.84	13.40	4.02	.0507	.0374	.0229	.0145	0.86	.0175	.0007	2.9
1896, ...	0.75	12.69	3.37	.0759	.0486	.0309	.0177	1.01	.0187	.0010	2.9
1897, ...	0.94	17.62	5.31	.0715	.0533	.0306	.0227	0.77	.0151	.0015	2.9

Blackstone River below Sewage Precipitation Works.

Year.	Color.	Residue Total.	Loss on Ignition.	Ammonia Free.	Albuminoid Total.	Dissolved.	Suspended.	Chlorine.	Nitrates.	Nitrites.	Hardness.
1888, ...	0.64	–	–	.2112	.1040	–	–	1.21	.0370	.0029	–
1889, ...	0.76	–	–	.2841	.1198	.0629	.0569	1.06	.0235	.0024	–
1890, ...	0.74	–	–	.2253	.1177	.0581	.0596	1.26	.0381	.0016	–
1891, ...	0.80	15.62	4.52	.4080	.1303	.0695	.0608	1.91	.0358	.0031	4.6
1892, ...	0.53	19.35	5.29	.3633	.1442	.0737	.0705	2.21	.0278	.0033	7.2
1893, ...	0.74	25.65	6.54	.3757	.1447	.0864	.0583	1.98	.0369	.0070	7.4
1894, ...	0.60	25.75	6.61	.4228	.1309	.0946	.0363	2.13	.0316	.0047	7.9
1895, ...	0.79	19.14	4.78	.2298	.0840	.0573	.0267	1.52	.0347	.0040	5.8
1896, ...	0.40	24.28	6.36	.2645	.0930	.0615	.0315	1.91	.0356	.0071	8.3
1897, ...	0.75	19.94	4.59	.2447	.0843	.0630	.0213	1.33	.0300	.0047	5.4

Blackstone River at Uxbridge.

Year.	Color.	Residue Total.	Loss on Ignition.	Ammonia Free.	Albuminoid Total.	Dissolved.	Suspended.	Chlorine.	Nitrates.	Nitrites.	Hardness.
1888, ...	0.45	–	–	.0979	.0284	–	–	0.61	.0322	.0008	–
1889, ...	0.28	–	–	.0992	.0300	.0191	.0109	0.60	.0253	.0009	–
1890, ...	0.25	–	–	.1168	.0214	.0152	.0062	0.66	.0272	.0006	–
1891, ...	0.27	8.32	1.94	.1647	.0272	.0197	.0075	0.77	.0396	.0008	2.8
1892, ...	0.21	8.59	1.90	.2113	.0222	.0153	.0069	0.82	.0326	.0007	2.8
1893, ...	0.40	9.45	1.91	.1603	.0256	.0167	.0089	1.00	.0424	.0029	3.2
1894, ...	0.51	10.80	1.97	.1372	.0242	.0187	.0055	1.22	.0460	.0032	4.0
1895, ...	0.64	10.56	2.44	.1081	.0315	.0243	.0072	1.05	.0439	.0037	3.9
1896, ...	0.42	10.77	2.50	.1209	.0308	.0249	.0059	1.09	.0405	.0054	4.2
1897, ...	0.59	10.31	2.50	.1126	.0298	.0248	.0050	1.04	.0481	.0035	3.8

Blackstone River at Millville.

Year.	Color.	Residue Total.	Loss on Ignition.	Ammonia Free.	Albuminoid Total.	Dissolved.	Suspended.	Chlorine.	Nitrates.	Nitrites.	Hardness.
1888, ...	0.47	–	–	.0444	.0253	–	–	0.44	.0242	.0005	–
1889, ...	0.38	–	–	.0450	.0277	.0206	.0071	0.43	.0160	.0004	–
1890, ...	0.34	–	–	.0587	.0211	.0162	.0049	0.46	.0240	.0004	–
1891, ...	0.32	6.05	1.83	.0807	.0293	.0194	.0099	0.55	.0275	.0005	1.9
1892, ...	0.35	6.03	1.62	.0896	.0249	.0180	.0069	0.54	.0218	.0004	1.8
1893, ...	0.40	6.23	1.53	.0899	.0288	.0225	.0063	0.66	.0289	.0008	2.0
1894, ...	0.49	6.37	1.90	.0528	.0219	.0173	.0046	0.73	.0232	.0008	2.5
1895, ...	0.58	7.47	2.27	.0501	.0253	.0189	.0064	0.74	.0278	.0016	2.7
1896, ...	0.40	7.34	1.64	.0549	.0248	.0185	.0063	0.76	.0347	.0018	2.8
1897, ...	0.53	7.07	2.14	.0528	.0262	.0219	.0043	0.73	.0332	.0014	2.6

BLACKSTONE RIVER.

AVERAGES OF CHEMICAL ANALYSES OF WATER FROM THE BLACKSTONE RIVER FOR SIX MONTHS, FROM JUNE TO NOVEMBER, INCLUSIVE, OF EACH YEAR FROM 1887 TO 1897, INCLUSIVE.

Blackstone River between Mill Brook Channel and the Sewage Precipitation Works.

[Parts per 100,000.]

MONTHS.	Color.	Residue on Evaporation.		Ammonia.				Chlorine.	Nitrogen as		Hardness.
		Total.	Loss on Ignition.	Free.	Albuminoid. Total.	Albuminoid. Dissolved.	Albuminoid. Suspended.		Nitrates.	Nitrites.	
June-Nov., 1887, ...	0.91	–	–	.2686	.1741	–	–	1.35	.0160	–	–
" " 1888, ...	0.76	–	–	.2658	.1112	.0557	.0555	1.50	.0382	.0041	–
" " 1889, ...	0.86	–	–	.3980	.1430	.0772	.0658	1.32	.0177	.0026	–
" " 1890, ...	1.14	9.92	3.03	.2107	.1246	.0673	.0573	1.07	.0250	.0015	2.9
" " 1891, ...	1.10	17.42	5.59	.4913	.1950	.1127	.0823	2.29	.0192	.0037	5.0
" " 1892, ...	0.52	20.75	6.30	.3547	.1433	.0708	.0725	2.43	.0227	.0108	6.1
" " 1893, ...	0.40	16.98	4.55	.1480	.0588	.0240	.0348	1.01	.0115	.0015	6.3
" " 1894, ...	0.66	16.93	4.76	.0548	.0380	.0236	.0144	0.74	.0115	.0005	4.4
" " 1895, ...	0.49	14.17	4.50	.0613	.0414	.0243	.0171	0.92	.0163	.0006	3.4
" " 1896, ...	0.51	12.90	2.93	.0780	.0415	.0282	.0133	0.97	.0147	.0015	3.4
" " 1897, ...	0.85	26.45	7.68	.1130	.0674	.0362	.0312	0.89	.0090	.0024	4.2*

Blackstone River below Sewage Precipitation Works.

MONTHS.	Color.	Residue on Evaporation.		Ammonia.				Chlorine.	Nitrogen as		Hardness.
		Total.	Loss on Ignition.	Free.	Albuminoid. Total.	Albuminoid. Dissolved.	Albuminoid. Suspended.		Nitrates.	Nitrites.	
June-Nov., 1887, ...	0.91	–	–	.2686	.1741	–	–	1.35	.0160	–	–
" " 1888, ...	0.76	–	–	.2658	.1112	.0557	.0555	1.50	.0382	.0041	–
" " 1889, ...	0.86	–	–	.3980	.1430	.0772	.0658	1.32	.0177	.0026	–
" " 1890, ...	0.97	11.36	3.10	.2907	.1492	.0722	.0770	1.46	.0270	.0018	3.9
" " 1891, ...	1.05	22.25	6.60	.6367	.1508	.0883	.0625	2.61	.0233	.0040	6.2
" " 1892, ...	0.63	26.80	7.75	.5240	.1810	.0958	.0852	3.13	.0137	.0050	10.3
" " 1893, ...	0.51	30.00	7.13	.5680	.1453	.0900	.0553	2.76	.0285	.0126	10.9
" " 1894, ...	0.40	29.30	5.86	.6189	.1390	.1113	.0277	2.63	.0212	.0071	10.6
" " 1895, ...	0.71	22.15	5.18	.3246	.0898	.0597	.0301	1.86	.0267	.0063	7.3
" " 1896, ...	0.30	26.03	6.53	.2831	.0898	.0600	.0298	2.10	.0217	.0118	9.7
" " 1897, ...	0.73	25.98	4.97	.3650	.1122	.0782	.0340	1.61	.0207	.0063	6.9

Blackstone River at Uxbridge.

MONTHS.	Color.	Residue on Evaporation.		Ammonia.				Chlorine.	Nitrogen as		Hardness.
		Total.	Loss on Ignition.	Free.	Albuminoid. Total.	Albuminoid. Dissolved.	Albuminoid. Suspended.		Nitrates.	Nitrites.	
June-Nov., 1887, ...	0.39	–	–	.1129	.0271	–	–	0.79	.0360	–	–
" " 1888, ...	0.38	6.42	1.52	.1155	.0288	.0222	.0066	0.68	.0310	.0007	–
" " 1889, ...	0.32	–	–	.1133	.0296	.0192	.0104	0.66	.0333	.0009	–
" " 1890, ...	0.26	8.86	2.12	.1629	.0231	.0174	.0057	0.79	.0259	.0005	2.9
" " 1891, ...	0.20	10.16	2.61	.2280	.0175	.0117	.0058	1.04	.0425	.0007	3.6
" " 1892, ...	0.13	9.36	1.88	.2840	.0227	.0162	.0065	0.99	.0313	.0007	3.1
" " 1893, ...	0.24	11.74	2.37	.1985	.0207	.0140	.0067	1.20	.0623	.0050	4.2
" " 1894, ...	0.35	13.07	2.03	.1456	.0243	.0183	.0060	1.57	.0678	.0050	4.9
" " 1895,† . . .	0.56	12.95	2.69	.0906	.0258	.0182	.0076	1.34	.0631	.0065	4.7
" " 1896, ...	0.33	12.68	2.67	.1129	.0257	.0221	.0036	1.38	.0477	.0091	5.0
" " 1897, ...	0.48	11.60	2.47	.1029	.0280	.0215	.0065	1.32	.0652	.0051	4.3

Blackstone River at Millville.

MONTHS.	Color.	Residue on Evaporation.		Ammonia.				Chlorine.	Nitrogen as		Hardness.
		Total.	Loss on Ignition.	Free.	Albuminoid. Total.	Albuminoid. Dissolved.	Albuminoid. Suspended.		Nitrates.	Nitrites.	
June-Nov., 1887, ...	0.31	–	–	.0468	.0220	–	–	0.51	.0210	–	–
" " 1888, ...	0.41	5.22	1.40	.0467	.0296	.0233	.0063	0.50	.0278	.0004	–
" " 1889, ...	0.38	–	–	.0499	.0273	.0213	.0060	0.45	.0167	.0003	–
" " 1890, ...	0.26	6.71	2.24	.0736	.0196	.0152	.0044	0.53	.0229	.0003	2.3
" " 1891, ...	0.24	7.48	2.35	.1105	.0384	.0234	.0150	0.72	.0308	.0006	2.2
" " 1892, ...	0.37	6.70	1.62	.1143	.0294	.0210	.0084	0.63	.0217	.0002	2.0
" " 1893, ...	0.23	7.43	1.73	.0677	.0119	.0087	.0031	0.77	.0385	.0011	2.6
" " 1894, ...	0.47	8.42	2.16	.0510	.0172	.0139	.0033	0.89	.0273	.0012	2.8
" " 1895, ...	0.51	8.67	2.55	.0356	.0233	.0180	.0053	0.90	.0383	.0024	3.2
" " 1896, ...	0.35	8.53	1.69	.0484	.0237	.0180	.0057	0.97	.0413	.0027	3.3
" " 1897, ...	0.45	7.66	1.98	.0509	.0258	.0210	.0048	0.92	.0445	.0019	3.1

* Average of five months. † Average of five months. No sample was obtained in June.

BLACKSTONE RIVER.

Chemical Examination of Water from Blackstone River between

[Parts per 100,000.]

	Number.	Date of Collection.	Appearance.			Residue on Evaporation.					
			Turbidity.	Sediment.	Color.	Total Residue.			Loss on Ignition.		
						Total.	Dis-solved.	Sus-pended.	Total.	Dis-solved.	Sus-pended.
		1897.									
1	18360	Jan. 26	Distinct.	Cons.	1.20	8.40	8.20	0.20	2.90	2.80	0.10
2	18542	Feb. 17	Distinct.	Cons.	1.20	9.50	7.70	1.80	3.00	2.70	0.30
3	18816	Mar. 19	Distinct.	Cons.	1.00	12.30	9.20	3.10	5.20	3.20	2.00
4	19096	Apr. 21	Distinct.	Slight.	0.65	6.50	5.40	1.10	1.70	1.40	0.30
5	19287	May 19	Decided.	Cons.	1.20	7.30	5.60	1.70	1.90	1.80	0.10
6	19497	June 16	Decided.	Cons.	0.90	10.50	5.20	5.30	3.20	1.50	1.70
7	19854	July 21	Distinct.	Cons., dirty.	1.40	14.80	8.20	6.60	3.80	2.00	1.80
8	20108	Aug. 16	Cons.	Heavy.	0.50	43.00	13.60	29.40	7.60	4.00	3.60
9	20629	Sept. 23	Distinct.	Cons., rusty.	0.30	54.00	50.40	3.60	22.00	22.00	0.00
10	20914	Oct. 20	Distinct, milky.	Cons.	0.33	24.20	22.50	1.70	5.70	5.00	0.70
11	21283	Nov. 17	Cons.	Heavy.	1.65	12.20	9.50	2.70	3.80	1.40	2.40
12	21629	Dec. 22	Decided.	Cons.	0.95	8.70	7.30	1.40	2.90	2.80	0.10
13	Av..	....	....	....	0.94	17.62	12.73	4.89	5.31	4.22	1.09

Odor, decidedly musty and disagreeable.—— The samples were collected from the river, about 200 Thursday, No. 18816 on Friday, and the other samples on Wednesday. The samples were collected

Chemical Examination of Water from Blackstone

[Parts per 100,000.]

	Number.	Date of Collection.	Appearance.			Residue on Evaporation.					
			Turbidity.	Sediment.	Color.	Total Residue.			Loss on Ignition.		
						Total.	Dis-solved.	Sus-pended.	Total.	Dis-solved.	Sus-pended.
		1897.									
1	18361	Jan. 26	Distinct.	Cons.	0.40	15.30	13.80	1.50	4.50	3.80	0.70
2	18543	Feb. 17	Distinct.	Cons.	1.05	14.20	12.20	2.00	4.60	4.10	0.50
3	18817	Mar. 19	Distinct.	Cons.	0.70	15.60	12.90	2.70	5.10	4.30	0.80
4	19097	Apr. 21	Distinct.	Slight.	0.65	11.80	10.20	1.60	3.30	2.00	1.30
5	19288	May 19	Decided.	Cons.	0.90	15.30	12.50	2.80	4.30	2.90	1.40
6	19498	June 16	Decided.	Cons.	0.92	16.00	11.40	4.60	3.20	2.10	1.10
7	19855	July 21	Distinct.	Cons.	1.25	19.80	16.20	3.60	4.40	3.60	0.80
8	20109	Aug. 16	Cons.	Heavy.	0.60	39.00	16.40	22.60	6.80	4.00	2.80
9	20630	Sept. 23	Slight, milky.	Cons., rusty.	0.70	26.00	21.50	4.50	3.60	3.60	0.00
10	20915	Oct. 20	Distinct, milky.	Cons.	0.47	31.30	27.10	4.20	4.60	3.90	0.70
11	21284	Nov. 17	Cons.	Heavy.	0.43	23.80	19.20	4.60	7.20	4.30	2.90
12	21630	Dec. 22	Decided.	Cons.	0.95	11.20	9.80	1.40	3.50	3.20	0.30
13	Av..	....	....	....	0.75	19.94	15.27	4.67	4.59	3.48	1.11

Odor, decidedly musty and disagreeable, sometimes offensive on heating.—— The samples were Sewage Precipitation Works enters the river. No. 20109 was collected on Monday, No. 18361 on samples were collected between 9.55 and 10.45 A.M.

BLACKSTONE RIVER.

Mill Brook Channel and the Worcester Sewage Precipitation Works.

[Parts per 100,000]

Ammonia.					Nitrogen as		Iron.			
	Albuminoid.									
Free.	Total.	Dis-solved.	Sus-pended.	Chlorine.	Nitrates.	Nitrites.	Unfiltered.	Filtered.	Hardness.	
.0224	.0300	.0264	.0036	0.84	.0100	.0002	0.5300	0.3400	1.6	1
.0120	.0362	.0298	.0064	0.55	.0150	.0004	0.3700	0.2300	1.7	2
.0736	.0652	.0324	.0328	1.05	.0300	.0010	0.6500	0.4200	2.2	3
.0072	.0308	.0186	.0122	0.38	.0160	.0003	0.1750	0.0750	1.6	4
.0240	.0384	.0214	.0170	0.45	.0070	.0004	0.2900	0.1450	1.6	5
.0168	.0394	.0242	.0152	0.27	.0050	.0003	0.3600	0.1100	1.7	6
.0256	.0716	.0376	.0340	0.67	.0020	.0002	0.3300	0.1500	2.1	7
.3280	.1400	.0540	.0860	1.58	.0200	.0110	1.8000	0.1300	3.8	8
.1120	.0620	.0380	.0240	0.87	.0030	.0009	8.0000	4.8000	*	9
.1560	.0270	.0250	.0020	1.33	.0070	.0015	2.2000	1.8000	11.0	10
.0394	.0648	.0386	.0262	0.60	.0170	.0006	0.4000	0.1120	2.6	11
.0410	.0348	.0218	.0130	0.63	.0490	.0007	0.1620	0.0660	2.1	12
.0715	.0533	.0306	.0227	0.77	.0151	.0015	1.2722	0.6982	2.9	13

feet below the iron bridge. No. 20108 was collected on Monday, No. 18360 on Tuesday, No. 20629 on between 9.35 and 10.30 A.M.

* Strongly acid.

River, below the Worcester Sewage Precipitation Works.

[Parts per 100,000.]

Ammonia.					Nitrogen as		Iron.			
	Albuminoid.									
Free.	Total.	Dis-solved.	Sus-pended.	Chlorine.	Nitrates.	Nitrites.	Unfiltered.	Filtered.	Hardness.	
.1376	.0572	.0504	.0068	1.14	.0200	.0016	0.4200	0.1300	1.4	1
.1440	.0656	.0568	.0088	1.03	.0280	.0020	0.3800	0.2100	3.9	2
.1536	.0640	.0536	.0104	1.13	.0400	.0015	0.5000	0.1800	4.9	3
.1040	.0458	.0380	.0078	0.85	.0380	.0032	0.1650	0.0450	4.2	4
.1440	.0634	.0526	.0108	1.30	.0350	.0090	0.1600	0.0700	4.9	5
.1440	.0610	.0350	.0260	0.98	.0380	.0065	0.2800	0.1200	4.3	6
.2960	.1480	.1260	.0220	1.81	.0030	.0000	0.3100	0.1300	5.6	7
.5000	.1380	.0630	.0750	1.73	.0030	.0200	1.5000	0.1400	5.9	8
.4560	.1340	.1130	.0210	1.98	.0150	.0013	0.5400	0.1050	5.9	9
.4640	.0800	.0690	.0110	2.53	.0150	.0060	1.2800	0.0300	11.0	10
.3300	.1124	.0634	.0490	0.62	.0500	.0040	0.4320	0.0520	8.9	11
.0634	.0418	.0348	.0070	0.83	.0750	.0017	0.1600	0.0760	3.8	12
.2447	.0843	.0630	.0213	1.33	.0300	.0047	0.5106	.1073	5.4	13

collected from the river, above Millbury and below the point where the effluent from the Worcester Tuesday, No. 20630 on Thursday, No. 18817 on Friday, and the other samples on Wednesday. The

BLACKSTONE RIVER.

Chemical Examination of Water from Blackstone River at Uxbridge.

[Parts per 100,000.]

Number.	Date of Collection.	Appearance.			Residue on Evaporation.		Ammonia.				Chlorine.	Nitrogen as		Oxygen Consumed.	Hardness.
								Albuminoid.							
		Turbidity.	Sediment.	Color.	Total.	Loss on Ignition.	Free.	Total.	Dissolved.	Sus-pended.		Nitrates.	Nitrites.		
	1897.														
18330	Jan. 21	Slight.	Slight.	0.60	13.20	3.80	.2600	.0470	.0430	.0040	0.90	.0130	.0013	.43	4.2
18547	Feb. 18	Slight.	Slight.	0.55	9.70	3.00	.1408	.0376	.0332	.0044	0.86	.0280	.0015	.50	3.5
18812	Mar. 19	Slight, milky.	Slight.	0.60	6.40	1.90	.0672	.0284	.0280	.0004	0.52	.0180	.0010	.45	2.7
19102	Apr. 22	V. slight.	Slight.	0.65	8.00	1.80	.0848	.0228	.0188	.0040	0.72	.0300	.0014	.36	3.0
19295	May 20	Distinct.	Cons.	0.68	9.00	2.60	.1200	.0252	.0184	.0068	0.84	.0450	.0055	.37	3.5
19494	June 17	Slight.	Cons.	0.46	9.10	2.30	.1040	.0250	.0190	.0060	0.75	.0480	.0080	.45	3.6
19868	July 22	Slight.	Slight.	0.25	10.60	2.25	.0094	.0220	.0202	.0018	1.40	.0850	.0130	.35	4.2
20156	Aug. 19	V. slight.	Slight.	0.43	9.85	2.15	.0126	.0240	.0194	.0046	1.13	.0680	.0030	.40	3.6
20613	Sept. 23	Slight.	Slight.	0.30	12.60	2.70	.1536	.0300	.0138	.0162	1.44	.0600	.0030	.32	4.3
20936	Oct. 21	V. slight.	Cons.	0.48	16.20	2.75	.2400	.0338	.0256	.0082	2.15	.0950	.0025	.39	6.0
21291	Nov. 18	Decided.	Cons.	0.98	11.25	2.65	.0980	.0334	.0312	.0022	1.04	.0350	.0010	.50	4.2
21623	Dec. 22	Decided.	V. slight.	1.15	7.80	2.10	.0610	.0290	.0272	.0018	0.72	.0520	.0010	.58	2.9
Av...	....	....	....	0.59	10.31	2.50	.1126	.0298	.0248	.0050	1.04	.0481	.0035	.42	3.8

Odor, generally distinctly musty, frequently vegetable or unpleasant. —— The samples were collected from the canal leading from the upper dam of the Calumet Woolen Company to the mill, just before the water passed the screens.

Chemical Examination of Water from Blackstone River at Millville, Blackstone.

[Parts per 100,000.]

Number.	Date of Collection.	Appearance.			Residue on Evaporation.		Ammonia.				Chlorine.	Nitrogen as		Oxygen Consumed.	Hardness.
								Albuminoid.							
		Turbidity.	Sediment.	Color.	Total.	Loss on Ignition.	Free.	Total.	Dissolved.	Sus-pended.		Nitrates.	Nitrites.		
	1897.														
18331	Jan. 21	Slight.	Cons.	.58	9.30	3.70	.0992	.0300	.0292	.0008	0.63	.0180	.0005	.44	2.6
18548	Feb. 18	V. slight.	Slight.	.55	6.60	2.60	.0656	.0252	.0230	.0022	0.56	.0170	.0005	.68	2.3
18811	Mar. 18	Slight, milky.	Slight.	.58	5.20	1.90	.0448	.0244	.0216	.0028	0.42	.0120	.0005	.42	1.8
19103	Apr. 22	V. slight.	Cons.	.62	6.00	1.30	.0388	.0286	.0230	.0056	0.58	.0200	.0005	.39	2.1
19297	May 20	Slight.	Cons.	.65	5.70	2.00	.0400	.0238	.0176	.0062	0.55	.0280	.0030	.40	2.1
19495	June 17	Slight.	Cons.	.55	6.50	1.80	.0520	.0300	.0200	.0100	0.51	.0320	.0040	.48	2.3
19869	July 22	V. slight.	Slight.	.32	7.55	1.80	.0054	.0216	.0168	.0048	1.20	.0650	.0040	.37	4.6
20150	Aug. 19	V. slight.	Slight.	.47	6.15	2.10	.0028	.0266	.0192	.0074	0.62	.0300	.0005	.48	1.7
20628	Sept. 23	V. slight.	Slight.	.32	8.95	2.25	.0672	.0228	.0212	.0016	1.29	.0450	.0013	.31	3.4
20937	Oct. 21	V. slight.	Slight.	.35	9.35	1.85	.1040	.0264	.0246	.0018	1.16	.0750	.0012	.40	3.5
21302	Nov. 18	Slight.	Cons.	.70	7.45	2.10	.0740	.0274	.0242	.0032	0.72	.0200	.0007	.54	3.1
21658	Dec. 23	Decided.	Heavy.	.68	6.10	2.30	.0396	.0274	.0218	.0056	0.54	.0360	.0007	.59	2.1
Av...	....	....	....	.53	7.07	2.14	.0528	.0262	.0219	.0043	0.73	.0332	.0014	.46	2.6

Odor, generally distinctly musty, occasionally vegetable or unpleasant, sometimes becoming stronger on heating. —— The samples were collected from the river, just above the dam in the village of Millville.

Charles River.

Chemical Examination of Water from Charles River opposite the Works of the Milford Water Company.

[Parts per 100,000.]

Number.	Date of Collection.	Appearance.			Residue on Evaporation.		Ammonia.				Chlorine.	Nitrogen as		Oxygen Consumed.	Hardness.
		Turbidity.	Sediment.	Color.	Total.	Loss on Ignition.	Free.	Albuminoid. Total.	Albuminoid. Dissolved.	Albuminoid. Suspended.		Nitrates.	Nitrites.		
21500	1897. Dec. 13	V. slight.	None.	.90	4.20	1.65	.0020	.0196	.0164	.0032	.34	.0150	.0000	.70	1.3

Odor, faintly vegetable.

Concord River.

Chemical Examination of Water from the Concord River at Billerica.

[Parts per 100,000.]

Number.	Date of Collection.	Appearance.			Residue on Evaporation.		Ammonia.				Chlorine.	Nitrogen as		Oxygen Consumed.	Hardness.
		Turbidity.	Sediment.	Color.	Total.	Loss on Ignition.	Free.	Albuminoid. Total.	Albuminoid. Dissolved.	Albuminoid. Suspended.		Nitrates.	Nitrites.		
21264	1897. Nov. 16	V. slight.	Slight.	1.10	5.90	2.70	.0030	.0352	.0326	.0026	.52	.0130	.0002	1.13	1.6

Odor, faintly earthy, becoming distinctly vegetable and musty on heating. —— The sample was collected from the river, just below the Corner Bridge.

Hoosac River.

This river receives sewage from the city of North Adams and the town of Adams, which is discharged directly into the stream. The combined population of these places in 1895 was 26,972.

HOOSAC RIVER.

Chemical Examination of Water from the Hoosac River at Williamstown.

[Parts per 100,000.]

Number.	Date of Collection.	Appearance.			Residue on Evaporation.		Ammonia.				Chlorine.	Nitrogen as		Oxygen Consumed	Hardness.
		Turbidity.	Sediment.	Color.	Total.	Loss on Ignition.	Free.	Albuminoid Total.	Albuminoid Dissolved.	Albuminoid Suspended.		Nitrates.	Nitrites.		
	1897.														
18293	Jan. 19	Decided, clayey.	Cons.	.33	12.15	3.10	.0110	.0436	.0296	.0140	.30	.0250	.0007	.40	5.3
18523	Feb. 16	Distinct, clayey.	Cons.	.20	10.40	2.00	.0218	.0274	.0220	.0054	.36	.0280	.0004	.43	6.0
18788	Mar. 15	Distinct, milky.	Cons.	.20	7.30	1.70	.0006	.0212	.0144	.0068	.18	.0170	.0005	.32	4.6
19095	Apr. 20	Distinct.	Cons.	.10	6.20	1.25	.0006	.0124	.0098	.0026	.14	.0200	.0002	.25	3.6
19268	May 18	Slight, milky.	Slight.	.15	7.00	1.00	.0000	.0242	.0148	.0094	.21	.0150	.0005	.23	5.1
19471	June 15	V. slight.	Slight.	.17	8.30	1.90	.0114	.0214	.0132	.0082	.17	.0300	.0005	.24	5.4
19836	July 20	Distinct.	Cons.	.23	10.80	2.50	.0032	.0250	.0146	.0104	.30	.0280	.0010	.31	7.4
20138	Aug. 17	Distinct.	Cons.	.16	12.70	2.55	.0030	.0380	.0194	.0186	.34	.0180	.0016	.32	8.7
20612	Sept. 21	Distinct.	Cons.	.28	14.20	2.45	.0022	.0384	.0228	.0156	.40	.0150	.0020	.29	10.3
20882	Oct. 18	Slight.	Cons.	.35	13.80	2.70	.0816	.0422	.0182	.0240	.38	.0450	.0010	.32	9.9
21262	Nov. 16	Decided.	Heavy.	.36	8.10	2.25	.0032	.0220	.0156	.0064	.22	.0230	.0006	.38	5.7
21620	Dec. 21	Decided.	Cons.	.18	8.10	2.50	.0118	.0116	.0082	.0034	.28	.0390	.0001	.22	4.9

Averages by Years.

-	1888	-	-	.10	10.21	1.65	.0040	.0187	.0143	.0044	.24	.0306	.0010	-	-
-	1894	-	-	.23	10.77	2.13	.0111	.0265	.0169	.0096	.35	.0157	.0009	.34	7.3
-	1895	-	-	.28	12.41	2.95	.0146	.0334	.0207	.0127	.39	.0162	.0013	.46	8.1
-	1896	-	-	.21	11.83	2.91	.0261	.0326	.0217	.0109	.44	.0323	.0015	.44	8.1
-	1897	-	-	.23	9.92	2.16	.0125	.0273	.0169	.0104	.27	.0252	.0008	.31	6.4

NOTE to analyses of 1897: Odor, generally distinctly musty, occasionally vegetable or disagreeable. —— The samples were collected from the river, at the bridge near the Williamstown station on the Fitchburg Railroad.

HOUSATONIC RIVER.

This river receives the sewage of the city of Pittsfield, which is discharged in an unpurified state into the river above the point at which samples were collected for analysis. The population of Pittsfield in 1895 was 20,461.

HOUSATONIC RIVER.

Chemical Examination of Water from the Housatonic River at New Lenox.

[Parts per 100,000.]

Number.	Date of Collection.	Appearance. Turbidity.	Appearance. Sediment.	Appearance. Color.	Residue on Evaporation. Total.	Residue on Evaporation. Loss on Ignition.	Ammonia. Free.	Ammonia. Albuminoid. Total.	Ammonia. Albuminoid. Dissolved.	Ammonia. Albuminoid. Suspended.	Chlorine.	Nitrogen as Nitrates.	Nitrogen as Nitrites.	Oxygen Consumed.	Hardness.
	1897.														
18389	Jan. 27	Distinct, milky.	Cons.	.15	14.10	4.10	.0194	.0312	.0234	.0078	.32	.0170	.0008	.36	6.3
18612	Feb. 22	Slight, milky.	Slight.	.15	12.55	3.20	.0364	.0290	.0190	.0100	.32	.0280	.0022	.37	8.1
18832	Mar. 22	Distinct.	Cons.	.40	5.30	1.60	.0064	.0208	.0186	.0022	.08	.0100	.0002	.48	3.6
19079	Apr. 20	Slight.	Cons.	.32	7.65	1.60	.0036	.0176	.0122	.0054	.14	.0150	.0001	.52	5.7
19310	May 24	Slight.	Cons.	.25	12.00	1.90	.0308	.0186	.0150	.0036	.19	.0300	.0010	.21	9.1
19496	June 17	Distinct.	Cons.	.24	9.80	2.10	.0128	.0240	.0154	.0086	.14	.0150	.0003	.34	7.1
19820	July 20	V. slight.	Cons.	.38	10.05	2.10	.0122	.0248	.0162	.0086	.12	.0080	.0003	.56	7.6
20124	Aug. 17	V. slight.	Cons.	.33	10.45	2.40	.0040	.0220	.0130	.0090	.14	.0130	.0006	.44	7.9
20587	Sept. 21	Slight.	Slight.	.38	12.30	2.00	.0116	.0228	.0180	.0048	.18	.0080	.0010	.32	8.9
20884	Oct. 19	Distinct.	Cons.	.40	14.65	2.85	.0440	.0300	.0226	.0074	.31	.0450	.0015	.37	10.8
21289	Nov. 17	Cons.	Heavy.	.52	9.90	3.30	.0014	.0296	.0168	.0128	.19	.0220	.0007	.52	7.4
21648	Dec. 23	Decided.	Slight.	.29	10.75	2.50	.0082	.0178	.0134	.0044	.19	.0330	.0006	.27	7.6

Averages by Years.

-	1894	-	-	.27	11.37	2.13	.0131	.0183	.0144	.0039	.25	.0204	.0024	.35	8.5
-	1895	-	-	.26	11.73	2.50	.0183	.0238	.0183	.0055	.25	.0173	.0038	.43	8.4
-	1896	-	-	.26	11.18	1.97	.0169	.0192	.0152	.0040	.22	.0208	.0036	.36	8.6
-	1897	-	-	.32	10.79	2.47	.0159	.0240	.0170	.0070	.19	.0203	.0008	.40	7.5

NOTE to analyses of 1897: Odor, generally distinctly musty, occasionally vegetable or disagreeable. —— The samples were collected from the river.

IPSWICH RIVER.

Chemical Examination of Water from the Ipswich River at Ipswich.

[Parts per 100,000.]

Number.	Date of Collection.	Appearance. Turbidity.	Appearance. Sediment.	Appearance. Color.	Residue on Evaporation. Total.	Residue on Evaporation. Loss on Ignition.	Ammonia. Free.	Ammonia. Albuminoid. Total.	Ammonia. Albuminoid. Dissolved.	Ammonia. Albuminoid. Suspended.	Chlorine.	Nitrogen as Nitrates.	Nitrogen as Nitrites.	Oxygen Consumed.	Hardness.
	1897.														
18348	Jan. 23	Slight.	Cons., brown.	.73	6.40	2.80	.0080	.0242	.0206	.0036	.71	.0070	.0001	.80	1.6

Odor, distinctly vegetable. —— The sample was collected from the river, at the dam of the Ipswich Mills.

Merrimack River.

This river receives the unpurified sewage of the cities of Concord, Manchester and Nashua, in New Hampshire, and Lowell, Lawrence, and Haverhill, in Massachusetts. The population of these cities at the time of the last census was as follows: —

City.	Population.	City.	Population.
Concord,	17,004*	Lowell,	84,367†
Manchester,	44,126*	Lawrence,	52,164†
Nashua,	19,311*	Haverhill,	30,209†

* 1890 census. † 1895 census.

In addition to the sewage from these cities, which are situated directly on the stream in the order named, the river receives much pollution from the cities and towns situated upon its tributaries.

The usual monthly examinations of the water of this river opposite the intake of the Lowell water works, which is situated just above the city of Lowell, and opposite the intake of the Lawrence water works, just above the city of Lawrence, have been continued during 1897, the detailed results of which may be found on pages 201 and 212 of this volume.

The city of Lowell is situated about 10 miles above the city of Lawrence, and the sewage from the former city is discharged directly into the river at several points in and below the city. In the following table a comparison is given of the analyses of samples of water collected from the river above Lowell and above Lawrence during the year 1897: —

Table comparing the Analyses above Lowell with those above Lawrence, 1897.

[Parts per 100,000.]

		Residue on Evaporation.		Ammonia.					Nitrogen as		
					Albuminoid.						
	Color.	Total.	Loss on Ignition.	Free.	Total.	Dissolved.	Sus-pended.	Chlorine.	Nitrates.	Nitrites.	Hardness.
Number of determinations compared,	12	12	12	12	12	12	12	12	12	12	12
Mean of analyses above Lowell,	.50	3.54	1.46	.0030	.0177	.0153	.0024	.146	.0067	.0001	1.0
Mean of analyses above Lawrence,	.56	3.84	1.54	.0049	.0228	.0186	.0042	.196	.0067	.0001	1.1
Increase,	.06	0.30	0.08	.0019	.0051	.0033	.0018	.050	.0000	.0000	0.1

MERRIMACK RIVER.

In order to compare these results with similar ones obtained in previous years, another table is presented, which shows the increase in impurities as the water passes from a point above Lowell to Lawrence, as given in the last line of the above table, and the corresponding increase in previous years: —

Increase in the Amount of Impurities in the Merrimack River Water, from a Point above Lowell to Lawrence, as determined by the Regular Monthly Examinations of Different Years.

[Parts per 100,000.]

DATE.	Color.	Residue on Evaporation.		Ammonia.				Chlorine.	Nitrogen as		Hardness.
		Total.	Loss on Ignition.	Free.	Albuminoid. Total.	Albuminoid. Dissolved.	Albuminoid. Suspended.		Nitrates.	Nitrites.	
Increase, 1887-1889, .	0.01	0.23	0.09	.0007	.0027	.0017	.0010	.026	.0003*	.0000	-
Increase, 1890, . .	0.05	0.62	0.22*	.0016	.0023	.0017	.0006	.028	.0020*	.0000	0.2
Increase, 1891, . .	0.02*	0.29	0.07	.0021	.0023	.0021	.0002	.035	.0030*	.0000	0.1
Increase, 1892, . .	0.06	0.48	0.12	.0019	.0037	.0037	.0000	.039	.0018*	.0000	0.0
Increase, 1893, . .	0.09	0.47	0.30	.0031	.0032	.0021	.0011	.035	.0002*	.0001	0.0
Increase, 1894, . .	0.02	0.15	0.04	.0028	.0032	.0032	.0000	.049	.0000	.0000	0.1
Increase, 1895, . .	0.11	0.52	0.33	.0022	.0063	.0046	.0017	.063	.0005	.0001	0.1
Increase, 1896, . .	0.02	0.51	0.24	.0034	.0053	.0047	.0006	.070	.0017	.0002	0.2
Increase, 1897, . .	0.06	0.30	0.08	.0019	.0051	.0033	.0018	.050	.0000	.0000	0.1

* Decrease.

The average flow of the river at Lawrence, for twenty-four hours, during the days on which samples were collected, was for the above periods, respectively, at the rate of 9,145, 9,948, 7,931, 5,434, 8,126, 5,459, 11,634, 5,886 and 8,230 cubic feet per second.

Nashua River.

The north branch of the Nashua River receives the unpurified sewage of the city of Fitchburg, which had, in 1895, a population of 26,409. The south branch of the river receives sewage from the town of Clinton, having a population, in 1895, of 11,497.

NASHUA RIVER.

Chemical Examination of Water from the North Branch of the Nashua River, below Fitchburg.

[Parts per 100,000.]

Number.	Date of Collection.	Appearance.			Residue on Evaporation.		Ammonia.				Chlorine.	Nitrogen as		Oxygen Consumed.	Hardness.
		Turbidity.	Sediment.	Color.	Total.	Loss on Ignition.	Free.	Albuminoid. Total.	Albuminoid. Dissolved.	Albuminoid. Suspended.		Nitrates.	Nitrites.		
	1897.														
18298	Jan. 19	Decided.	Cons.	.45	9.20	2.40	.0316	.0170	.0106	.0064	0.82	.0100	.0011	.73	1.9
18537	Feb. 17	Distinct.	Cons.	.48	7.45	2.80	.0478	.0500	.0408	.0092	0.68	.0030	.0006	.38	1.4
18874	Mar. 25	Distinct.	Cons.	.43	4.35	2.00	.0102	.0264	.0208	.0056	0.27	.0180	.0000	.49	0.8
19073	Apr. 20	Distinct.	Cons.	.60	4.60	1.65	.0110	.0328	.0220	.0108	0.38	.0130	.0004	.54	1.6
19281	May 18	Decided.	Cons.	.80	4.55	1.95	.0082	.0380	.0258	.0122	0.34	.0070	.0003	.70	1.1
19477	June 15	Slight.	Cons.	.63	5.20	1.85	.0080	.0378	.0250	.0128	0.34	.0220	.0004	.70	1.3
19863	July 21	Slight.	Cons.	.87	6.05	2.45	.0354	.0504	.0368	.0136	0.67	.0080	.0006	.88	2.0
20280	Aug. 23	Slight.	Cons.	.62	7.80	2.30	.0520	.0486	.0362	.0124	0.75	.0200	.0020	.67	2.3
20596	Sept. 21	Distinct.	Cons.	.60	9.25	2.35	.0800	.0618	.0460	.0158	0.94	.0030	.0015	.78	2.6
20883	Oct. 19	Distinct.	Cons.	.80	11.30	3.90	.1120	.0726	.0604	.0122	1.04	.0050	.0008	.98	2.6
21297	Nov. 18	Cons.	Cons.	.50	6.15	2.15	.0200	.0394	.0288	.0106	0.52	.0090	.0004	.74	1.7
21621	Dec. 21	Decided.	Cons.	.49	6.00	2.70	.0284	.0290	.0268	.0022	0.60	.0260	.0005	.63	1.8

Averages by Years.

-	1893	-	-	.57	7.46	2.16	.0461	.0360	.0257	.0103	0.69	.0118	.0018	.69	2.0
-	1894	-	-	.56	7.39	2.00	.0634	.0346	.0251	.0095	0.75	.0152	.0020	.58	1.9
-	1895	-	-	.59	8.10	2.58	.0832	.0423	.0319	.0104	0.75	.0134	.0010	.74	2.2
-	1896	-	-	.48	8.15	2.40	.0677	.0499	.0343	.0156	0.74	.0151	.0017	.69	2.0
-	1897	-	-	.61	6.82	2.37	.0370	.0420	.0317	.0103	0.61	.0120	.0007	.68	1.8

NOTE to analyses of 1897: Odor, generally distinctly musty, occasionally vegetable or unpleasant. —— The samples were collected from the river, about half a mile below the point where water from the tail-race of the Falulah Paper Company enters the stream.

NASHUA RIVER.

Chemical Examination of Water from the North Branch of the Nashua River, just above its Confluence with the South Branch at Lancaster.

[Parts per 100,000.]

Number.	Date of Collection.	Appearance.			Residue on Evaporation.		Ammonia.				Chlorine.	Nitrogen as		Oxygen Consumed.	Hardness.
								Albuminoid.							
		Turbidity.	Sediment.	Color.	Total.	Loss on Ignition.	Free.	Total.	Dissolved.	Sus-pended.		Nitrates.	Nitrites.		
	1897.														
18333	Jan. 22	Distinct.	Cons.	.50	7.40	3.10	.0928	.0388	.0316	.0072	.63	.0170	.0002	.60	2.1
18535	Feb. 17	Distinct.	Cons.	.43	6.15	2.05	.0328	.0304	.0242	.0062	.51	.0120	.0003	.54	1.7
18796	Mar. 16	Distinct.	Cons.	.40	3.85	1.15	.0078	.0226	.0186	.0040	.26	.0080	.0002	.45	0.9
19090	Apr. 21	Distinct.	Cons.	.48	4.40	1.40	.0220	.0236	.0202	.0034	.36	.0130	.0007	.55	1.1
19266	May 18	V. slight.	Cons.	.68	4.15	1.45	.0204	.0304	.0226	.0078	.28	.0100	.0006	.62	1.4
19486	June 16	Slight.	Slight.	.66	4.65	1.80	.0146	.0234	.0160	.0074	.20	.0180	.0010	.67	1.4
19852	July 21	Slight.	Cons.	.75	5.55	2.25	.0264	.0318	.0258	.0060	.40	.0100	.0011	.78	1.4
20151	Aug. 19	Slight.	Slight.	.53	6.15	2.05	.0264	.0318	.0246	.0072	.61	.0180	.0025	.59	1.6
21646	Dec. 23	Decided.	Cons.	.44	5.30	2.65	.0130	.0286	.0234	.0052	.50	.0290	.0005	.49	2.0

Averages by Years.

-	1895	-	-	.51	6.96	2.10	.0282	.0269	.0208	.0061	.77	.0236	.0019	.59	1.9
-	1896	-	-	.47	6.16	1.95	.0217	.0293	.0224	.0069	.55	.0155	.0019	.55	1.8
-	1897	-	-	.54	5.29	1.99	.0285	.0290	.0230	.0060	.42	.0150	.0008	.59	1.5

NOTE to analyses of 1897: Odor, generally distinctly musty, occasionally vegetable or unpleasant. —— The samples were collected from the river, at the railroad bridge, a short distance above its mouth.

NASHUA RIVER.

Chemical Examination of Water from the Quinepoxet River in Holden.

[Parts per 100,000.]

Number.	Date of Collection.	Appearance.			Residue on Evaporation.		Ammonia.				Chlorine.	Nitrogen as		Oxygen Consumed.	Hardness.
		Turbidity.	Sediment.	Color.	Total.	Loss on Ignition.	Free.	Albuminoid.				Nitrates.	Nitrites.		
								Total.	Dissolved.	Suspended					
	1897.														
18257	Jan. 15	Slight.	Cons.	0.65	4.95	2.45	.0028	.0270	.0250	.0020	.26	.0150	.0001	0.61	1.1
18406	Feb. 1	Slight.	Cons., dark.	0.63	4.10	1.40	.0072	.0390	.0346	.0044	.18	.0100	.0001	0.58	1.3
18689	Mar. 2	Slight.	Cons.	0.60	4.00	1.45	.0006	.0276	.0222	.0054	.29	.0080	.0000	0.58	0.5
18962	Apr. 5	V. slight.	Slight.	0.58	2.95	1.05	.0000	.0240	.0190	.0050	.15	.0030	.0000	0.54	0.3
19175	May 5	Distinct.	Slight.	0.80	2.75	1.20	.0016	.0250	.0208	.0042	.17	.0030	.0001	0.67	0.6
19366	June 1	Slight.	V. slight.	0.90	3.50	2.00	.0038	.0270	.0226	.0044	.13	.0030	.0000	0.71	0.7
19727	July 6	V. slight.	Slight.	0.88	3.45	1.65	.0118	.0246	.0190	.0056	.13	.0020	.0001	0.68	0.3
19979	Aug. 2	V. slight.	Slight.	1.08	4.05	2.20	.0040	.0322	.0272	.0050	.14	.0070	.0000	1.08	0.6
20364	Sept. 2	None.	V. slight.	0.52	3.45	1.60	.0014	.0184	.0164	.0020	.17	.0000	.0000	0.64	0.8
20716	Oct. 4	Slight.	Slight.	0.45	3.85	1.70	.0018	.0248	.0186	.0062	.21	.0050	.0001	0.50	0.9
21055	Nov. 5	V. slight.	Cons.	1.10	5.25	2.80	.0014	.0330	.0290	.0040	.39	.0030	.0002	1.18	1.3
21419	Dec. 1	Decided.	Cons.	1.00	4.25	1.90	.0018	.0274	.0236	.0038	.30	.0070	.0001	1.02	1.6

Averages by Years.

-	1892	-	-	0.62	3.70	1.49	.0014	.0194	.0158	.0036	.19	.0088	.0001	-	0.9
-	1894	-	-	0.61	3.85	1.47	.0041	.0214	.0171	.0043	.29	.0027	.0001	0.58	0.7
-	1895	-	-	0.77	4.47	1.97	.0020	.0289	.0239	.0050	.26	.0090	.0003	0.78	0.9
-	1896	-	-	0.64	3.74	1.67	.0012	.0250	.0210	.0040	.19	.0045	.0000	0.71	0.4
-	1897	-	-	0.77	3.88	1.78	.0032	.0275	.0232	.0043	.21	.0055	.0001	0.73	0.8

NOTE to analyses of 1897: Odor, distinctly vegetable and sometimes mouldy. —— The samples were collected from the river, at Smith's Woolen Mill in Holden, and 1,000 feet from the line between Holden and West Boylston.

NASHUA RIVER.

Chemical Examination of Water from the Stillwater River in Sterling.

[Parts per 100,000.]

Number.	Date of Collection.	Appearance.			Residue on Evaporation.		Ammonia.				Chlorine.	Nitrogen as		Oxygen Consumed.	Hardness.
								Albuminoid.							
		Turbidity.	Sediment.	Color.	Total.	Loss on Ignition.	Free.	Total.	Dissolved.	Suspended		Nitrates.	Nitrites.		
	1897.														
18258	Jan. 15	V. slight.	V. slight.	0.48	4.80	2.00	.0014	.0132	.0116	.0016	.19	.0070	.0001	0.59	0.9
18407	Feb. 1	V. slight.	V. slight.	0.50	3.50	1.00	.0008	.0138	.0134	.0004	.18	.0120	.0001	0.49	0.9
18690	Mar. 1	V. slight.	Slight.	0.45	3.20	1.20	.0002	.0128	.0120	.0008	.19	.0080	.0000	0.55	0.6
18963	Apr. 5	V. slight.	Slight.	0.42	2.65	0.85	.0008	.0134	.0134	.0000	.14	.0030	.0000	0.46	0.3
19176	May 5	V. slight.	Slight.	0.60	2.80	1.25	.0016	.0236	.0216	.0020	.12	.0030	.0000	0.62	0.6
19367	June 1	V. slight.	Slight.	0.70	2.95	1.50	.0012	.0230	.0176	.0054	.12	.0030	.0000	0.66	0.6
19726	July 6	V. slight.	Slight.	0.65	3.05	1.70	.0034	.0222	.0206	.0016	.10	.0000	.0000	0.64	0.6
19980	Aug. 2	V. slight.	V. slight.	1.04	3.90	1.85	.0014	.0256	.0232	.0024	.13	.0020	.0000	1.03	0.5
20365	Sept. 2	None.	V. slight.	0.61	3.40	1.60	.0012	.0272	.0220	.0052	.21	.0000	.0000	0.77	0.5
20717	Oct. 4	V. slight.	V. slight.	0.42	3.25	1.50	.0012	.0160	.0160	.0000	.16	.0000	.0000	0.44	0.6
21056	Nov. 5	V. slight.	Slight.	1.10	4.85	2.80	.0010	.0286	.0286	.0000	.33	.0020	.0000	1.07	1.8
21420	Dec. 1	V. slight.	Cons.	0.90	3.35	1.75	.0010	.0190	.0184	.0006	.22	.0050	.0000	0.68	1.3

Averages by Years.

-	1892	-	-	0.44	3.38	1.18	.0001	.0131	.0109	.0022	.13	.0072	.0000	-	0.9
-	1894	-	-	0.45	3.20	1.14	.0008	.0137	.0115	.0022	.18	.0017	.0000	.44	0.8
-	1895	-	-	0.52	3.48	1.45	.0008	.0179	.0161	.0018	.19	.0051	.0000	.58	0.9
-	1896	-	-	0.50	3.32	1.35	.0016	.0229	.0203	.0026	.16	.0035	.0000	.62	0.7
-	1897	-	-	0.66	3.47	1.58	.0013	.0199	.0182	.0017	.17	.0037	.0000	.67	0.8

NOTE to analyses of 1897: Odor, distinctly vegetable. —— The samples were collected from the river, at a highway bridge about 1 mile above the line between Sterling and West Boylston.

NASHUA RIVER.

Chemical Examination of Water from the South Branch of the Nashua River above Clinton.

[Parts per 100,000.]

Number.	Date of Collection.	Appearance.			Residue on Evaporation.		Ammonia.				Chlorine.	Nitrogen as		Oxygen Consumed.	Hardness.
		Turbidity.	Sediment.	Color.	Total.	Loss on Ignition.	Free.	Albuminoid. Total.	Albuminoid. Dissolved.	Albuminoid. Suspended.		Nitrates.	Nitrites.		
	1897.														
18289	Jan. 19	V. slight.	Slight.	.40	4.80	1.50	.0010	.0160	.0138	.0022	.21	.0030	.0001	.34	1.3
18405	Feb. 1	V. slight.	V. slight.	.42	4.05	1.30	.0002	.0168	.0168	.0000	.23	.0150	.0001	.48	1.1
18671	Mar. 1	Slight.	V. slight.	.48	4.05	1.35	.0004	.0206	.0146	.0060	.26	.0120	.0000	.50	0.9
18939	Mar. 31	V. slight.	V. slight.	.45	2.40	0.75	.0000	.0152	.0116	.0036	.18	.0050	.0000	.43	0.6
19145	May 3	Slight.	Slight.	.40	3.65	1.30	.0028	.0212	.0152	.0060	.22	.0050	.0000	.46	1.3
19365	May 31	Slight.	Slight.	.60	3.40	1.60	.0024	.0206	.0172	.0034	.14	.0050	.0000	.60	0.6
19693	July 1	Slight.	Cons.	.42	3.40	1.15	.0032	.0176	.0122	.0054	.20	.0030	.0001	.45	0.9
19961	Aug. 2	V. slight.	V. slight.	.93	3.95	1.90	.0020	.0274	.0256	.0018	.18	.0030	.0000	.94	1.1
20339	Sept. 1	V. slight.	Slight.	.44	3.90	1.50	.0014	.0158	.0134	.0024	.20	.0030	.0000	.50	1.1
20709	Oct. 4	V. slight.	Slight.	.30	3.80	1.60	.0002	.0088	.0082	.0006	.21	.0030	.0000	.26	1.3
20993	Oct. 27	V. slight.	Slight.	.30	3.80	0.90	.0024	.0096	.0092	.0004	.24	.0050	.0001	.19	2.7
21028	Nov. 1	V. slight.	Slight.	.16	4.10	1.15	.0002	.0100	.0100	.0000	.21	.0030	.0001	.16	1.6
21403	Dec. 1	Slight.	Slight.	.70	4.25	1.90	.0028	.0224	.0196	.0028	.29	.0080	.0000	.62	1.3

Averages by Years.

-	1888	-	-	.32	3.53	1.06	.0008	.0151	-	-	.18	.0097	.0001	-	-
-	1894	-	-	.44	3.81	1.27	.0014	.0154	.0123	.0031	.25	.0042	.0000	.42	1.1
-	1895	-	-	.46	4.00	1.44	.0017	.0226	.0189	.0037	.26	.0090	.0000	.53	1.3
-	1896	-	-	.43	3.56	1.37	.0023	.0199	.0167	.0032	.18	.0045	.0000	.49	1.2
-	1897*	-	-	.47	3.81	1.39	.0015	.0177	.0149	.0028	.21	.0057	.0000	.47	1.1

* Where more than one sample was collected in a month, the mean analysis for that month has been used in making the average.

NOTE to analyses of 1897: Odor, generally distinctly vegetable, occasionally mouldy or musty.—— The samples were collected from the river, at the dam of the Lancaster Manufacturing Company.

NASHUA RIVER.

Chemical Examination of Water from the South Branch of the Nashua River, just above its Confluence with the North Branch at Lancaster.

[Parts per 100,000.]

Number.	Date of Collection.	Appearance.			Residue on Evaporation.		Ammonia.				Chlorine.	Nitrogen as		Oxygen Consumed.	Hardness.
								Albuminoid.							
		Turbidity.	Sediment.	Color.	Total.	Loss on Ignition.	Free.	Total.	Dissolved.	Sus-pended.		Nitrates.	Nitrites.		
	1897.														
18305	Jan. 20	Distinct.	Cons.	.48	6.90	2.40	.0086	.0374	.0234	.0140	.48	.0150	.0004	.55	1.8
18536	Feb. 17	Distinct.	Slight.	.45	4.85	1.80	.0026	.0270	.0214	.0056	.29	.0080	.0003	.58	1.4
18797	Mar. 16	Slight.	Slight.	.42	3.50	1.15	.0046	.0182	.0150	.0032	.20	.0080	.0002	.46	0.9
19091	Apr. 21	Slight.	Cons.	.50	3.30	1.40	.0014	.0218	.0178	.0040	.21	.0100	.0002	.46	0.9
19267	May 18	V. slight.	Cons.	.87	3.50	1.30	.0110	.0280	.0232	.0048	.23	.0130	.0002	.69	1.1
19487	June 16	V. slight.	Cons.	.88	3.85	1.65	.0052	.0222	.0182	.0040	.16	.0050	.0003	.74	0.9
19853	July 21	Slight.	Cons.	.75	4.75	2.25	.0124	.0280	.0224	.0056	.24	.0070	.0003	.47	1.4
20152	Aug. 19	Slight.	Slight.	.52	4.60	2.35	.0070	.0278	.0226	.0052	.30	.0080	.0002	.61	1.1
20570	Sept. 20	V. slight.	Cons.	.40	4.70	1.80	.0424	.0268	.0224	.0044	.51	.0100	.0012	.42	1.7
20905	Oct. 20	Distinct.	Slight.	.50	5.10	1.75	.0026	.0294	.0226	.0068	.55	.0150	.0003	.50	1.3
21280	Nov. 17	Slight.	Cons.	.90	4.35	2.00	.0092	.0248	.0192	.0056	.34	.0150	.0006	.81	1.8
21647	Dec. 23	Slight.	Cons.	.58	4.25	1.80	.0032	.0166	.0142	.0024	.30	.0180	.0002	.49	1.4

Averages by Years.

-	1895	-	-	.53	4.66	1.77	.0167	.0238	.0185	.0053	.34	.0114	.0008	.61	1.4
-	1896	-	-	.45	4.72	1.69	.0094	.0216	.0180	.0036	.35	.0134	.0006	.53	1.6
-	1897	-	-	.60	4.47	1.80	.0092	.0257	.0202	.0055	.32	.0110	.0004	.56	1.3

NOTE to analyses of 1897: Odor of the first four samples, decidedly musty and unpleasant or disagreeable; of the next six samples, distinctly vegetable and musty or mouldy; of the last two samples, oily.—— The samples were collected from the river, at the Atherton Bridge, a short distance above its mouth.

STONY BROOK.

Stony Brook.

This stream has a watershed of about 14 square miles, a large portion of which is very densely populated. For much of its course the stream is confined in a walled channel, and for a considerable distance above its lower end the channel is covered. The samples of water from this stream were collected at Boylston Avenue, in Roxbury, below the point where the covered masonry channel begins. Above this point there are six storm overflows, which discharge sewage mingled with storm water directly into the brook, at times of high flow.

Chemical Examination of Water from Stony Brook, Boston.

[Parts per 100,000.]

Number.	Date of Collection.	Appearance.			Residue on Evaporation.		Ammonia.				Chlorine.	Nitrogen as		Oxygen Consumed.	Hardness.
		Turbidity.	Sediment.	Color.	Total.	Loss on Ignition.	Free.	Albuminoid Total.	Albuminoid Dissolved.	Albuminoid Suspended.		Nitrates.	Nitrites.		
	1897.														
18363	Jan. 26	Slight.	Cons.	0.30	16.00	6.10	.0382	.0230	.0206	.0024	2.20	.2400	.0004	.43	5.3
18630	Feb. 24	Distinct.	Cons., sandy.	0.50	9.70	3.25	.0328	.0364	.0312	.0052	1.11	.0500	.0007	.69	5.1
18865	Mar. 24	Decided.	Heavy.	0.60	10.00	4.00	.0432	.1004	.0502	.0502	1.00	.0800	.0020	.73	3.0
19130	Apr. 28	Distinct.	Cons.	0.30	13.00	3.90	.0160	.0270	.0266	.0004	1.27	.1100	.0011	.69	4.9
19329	May 26	Distinct.	Cons.	1.15	10.90	3.60	.0340	.0518	.0378	.0140	1.11	.0600	.0011	.78	4.3
19588	June 28	Distinct.	Cons.	0.96	14.10	4.00	.0640	.0290	.0210	.0080	1.42	.1400	.0018	.30	6.0
19955	July 28	Distinct.	Cons., brown.	0.36	15.20	3.75	.0514	.0322	.0272	.0050	1.85	.0800	.0060	.55	7.0
20327	Aug. 30	Distinct.	Slight.	0.62	14.70	4.15	.0268	.0490	.0362	.0128	1.65	.0600	.0035	.61	6.1
20668	Sept. 29	Distinct.	Cons.	0.50	16.20	5.05	.0816	.0334	.0314	.0020	1.78	.1200	0000	.37	7.1
20984	Oct. 27	Distinct.	Cons.	0.48	16.45	3.80	.0560	.0218	.0114	.0104	1.89	.1200	.0076	.28	7.7
21714	Dec. 29	Decided.	Cons., earthy.	0.35	12.50	3.65	.0324	.0400	.0166	.0234	1.50	.2150	.0007	.33	5.1
Av.	....	....	....	0.56	13.52	4.11	.0433	.0404	.0282	.0122	1.53	.1159	.0022	.52	5.6

Odor, generally distinctly musty and unpleasant, becoming sometimes disagreeable on heating. —— The samples were collected from the brook, at Boylston Avenue, Roxbury.

Ware River.

Chemical Examination of Water from Ware River at Cold Brook Station, Barre.

[Parts per 100,000.]

Number.	Date of Collection.	Appearance.			Residue on Evaporation.		Ammonia.				Chlorine.	Nitrogen as		Oxygen Consumed.	Hardness.
								Albuminoid.							
		Turbidity.	Sediment.	Color.	Total.	Loss on Ignition.	Free.	Total.	Dissolved.	Sus-pended.		Nitrates.	Nitrites.		
	1897.														
18238	Jan. 11	V. slight.	V. slight.	0.60	4.25	1.55	.0004	.0158	.0146	.0012	.18	.0050	.0003	0.69	0.8
18400	Feb. 1	V. slight.	Slight.	0.65	3.90	1.25	.0020	.0154	.0142	.0012	.14	.0070	.0001	0.52	1.4
18669	Mar. 1	V. slight.	V. slight.	0.65	3.70	1.35	.0016	.0152	.0142	.0010	.15	.0100	.0000	0.64	0.9
18938	Mar. 31	V. slight.	Slight.	0.53	2.60	1.15	.0006	.0126	.0116	.0010	.15	.0030	.0000	0.57	0.2
19161	May 3	V. slight.	Slight.	0.80	2.80	0.80	.0002	.0198	.0178	.0020	.12	.0030	.0000	0.69	0.5
19346	June 1	V. slight.	Slight.	1.10	3.80	1.55	.0006	.0226	.0146	.0080	.06	.0000	.0000	0.87	0.6
19704	July 1	V. slight.	Slight.	1.00	3.35	1.45	.0024	.0226	.0192	.0034	.10	.0000	.0000	0.69	0.5
19963	Aug. 2	V. slight.	Slight.	1.45	4.25	2.30	.0008	.0302	.0280	.0022	.13	.0030	.0000	1.52	0.6
20352	Sept. 1	V. slight.	V. slight.	0.93	3.75	1.80	.0012	.0220	.0196	.0024	.10	.0000	.0000	0.97	0.6
20710	Oct. 4	V. slight.	Slight.	0.68	3.40	1.80	.0008	.0200	.0194	.0006	.15	.0000	.0000	0.57	0.8
21011	Nov. 1	V. slight.	V. slight.	0.49	3.45	1.60	.0014	.0176	.0168	.0008	.20	.0020	.0000	0.64	1.0
21408	Dec. 1	V. slight.	Slight.	1.05	3.95	1.95	.0006	.0184	.0176	.0008	.21	.0060	.0000	0.88	1.1

Averages by Years.

-	1894	-	-	0.74	3.55	1.47	.0005	.0179	.0155	.0024	.14	.0023	.0000	.63	0.8
-	1895	-	-	0.78	3.96	1.70	.0014	.0219	.0199	.0020	.17	.0051	.0000	.79	0.9
-	1896	-	-	0.72	3.36	1.52	.0003	.0198	.0177	.0021	.11	.0038	.0000	.73	0.8
-	1897	-	-	0.83	3.60	1.55	.0010	.0193	.0173	.0020	.14	.0032	.0000	.69	0.7

NOTE to analyses of 1897: Odor, distinctly vegetable. —— The samples were collected from the river, at the railroad bridge, near Cold Brook station, in the south-easterly part of the town of Barre.

SUMMARY

OF

WATER SUPPLY STATISTICS;

ALSO

RECORDS OF RAINFALL AND FLOW OF STREAMS.

SUMMARY OF WATER SUPPLY STATISTICS.

At the end of the year 1897 the State contained 32 cities and 321 towns. The town of Bradford was annexed to the city of Haverhill during the year, and the new town of Westwood was set off from the town of Dedham, so that the total number of towns remains the same as in 1896.

During the year 1897 a public water supply was introduced for the first time into the towns of Groton and Sheffield, and important additions to many of the existing works were made to increase the capacity of the sources of supply.

The following table gives a classification by population of cities and towns having and not having a public water supply Dec. 31, 1897. The populations are taken from the census of 1895 : —

Population (1895).	Number of Places of Given Population having a Public Water Supply.	Total Population of Places in Preceding Column.	Number of Places of Given Population not having a Public Water Supply.	Total Population of Places in Preceding Column.
Under 500,	0	0	36	13,287
500-1,000,	4	3,301	55	42,503
1,000-1,500,	10	11,912	38	46,354
1,500-2,000,	9	15,722	30	51,754
2,000-2,500,	10	22,182	13	28,882
2,500-3,000,	7	19,867	11	29,624
3,000-3,500,	10	32,515	7	22,599
3,500-4,000,	5	18,219	1	3,569
4,000-4,500,	9	39,006	1	4,055
Above 4,500,	96	2,088,793	1	6,039
Totals,	160	2,251,517	193	248,666

From the totals given in the preceding table it will be seen that, although but 45.3 per cent. of the cities and towns in the State have a public water supply, yet the total population of places supplied represents 90.1 per cent. of the whole population of the State. The

number of people to whom a public water supply is available is somewhat less than the total population of the municipalities supplied, but the difference is not large.

There are now 10 towns having, by the census of 1895, a population exceeding 3,000, which are not provided with a public water supply. These are given in the following table: —

Towns.	Population in 1895.	Towns.	Population in 1895.
Blackstone,	6,039	Pepperell,	3,321
Barnstable,	4,055	Dudley,	3,203
North Andover,	3,569	Chelmsford,	3,162
Sutton,	3,420	Dartmouth,	3,107
Tewksbury,	3,379	Deerfield,	3,007

In the following table the various water supplies are classified according to the dates when a fairly complete system of supply was first introduced into a city or town: —

Years.	Number of Places supplied.	Years.	Number of Places supplied.
Previous to 1850,	6	1892,	1
1850-1859, inclusive,	4	1893,	3
1860-1869, inclusive,	10	1894,	3
1870-1879, inclusive,	44	1895,	5
1880-1889, inclusive,	68	1896,	5
1890,	4	1897,	2
1891,	5	Total,	160

During the year 1897 the town of Watertown took possession of the works which were formerly owned by a water company. At the end of the year all of the 32 cities in the State, having an aggregate population of 1,640,503, owned their water works. Of the 128 towns having a public water supply, 80, with a population of 400,424, own their works; while 48, having a population of 210,590, are supplied by private companies. The total population in both cities and towns owning their works is 2,040,927, against 210,590 in those supplied by private companies.

The following table gives statistics with regard to the consumption of water in many of the cities and towns in this State where such records are kept. The populations for 1897, as given in the table, were obtained by adding two-fifths of the increase in population from 1890 to 1895 to the population as determined by the census taken in the latter year. The daily consumption per inhabitant has been obtained by dividing the average daily consumption by the estimated total population of the city or town in 1897, and consequently is somewhat less than the amount used per consumer, because there are in all cities and towns a greater or less number of people who do not use the public water supply. The difference between the number of inhabitants and consumers would account to a large extent for the low rate per inhabitant in some of the towns where works have been in operation for a short time only, and where, in consequence, water has not been generally introduced. In some towns the population during the summer months is much greater than shown by census returns, and in such cases the consumption per inhabitant as given in the table is somewhat higher than it would be if allowance was made for the increased population in the summer.

Statistics relating to the Consumption of Water in Various Cities and Towns.

City or Town.	Population. 1897.	Average Daily Consumption. Gallons. 1897.	Daily Consumption per Inhabitant. Gallons. 1897.	City or Town.	Population. 1897.	Average Daily Consumption. Gallons. 1897.	Daily Consumption per Inhabitant. Gallons. 1897.
Abington and Rockland.	9,832	338,000	34	Canton, . . .	4,675	164,000	35
Andover, . .	6,147	317,000	52	Cohasset, . .	2,484	66,000	26
Attleborough, .	8,572	353,000	41	Cottage City, . .	1,022	94,000	92
Avon, . . .	1,722	48,000	28	Danvers, . . .	8,472	618,000	73
Ayer, . . .	2,083	78,000	37	Dedham, . . .	7,247	500,000	69
Beverly, . . .	12,200	857,000	70	Easthampton, .	4,948	339,000	69
Boston (Cochituate Works).	491,100	57,867,000	118	Easton, . . .	4,436	96,000	22
Boston, Somerville, Chelsea, Everett (Mystic Works).	142,600	12,519,000	88	Fairhaven, . .	3,506	172,000	49
Braintree, . .	5,496	364,000	66	Fall River, . .	95,125	3,670,000	39
Bridgewater and E. Bridgewater.	7,748	190,000	25	Foxborough, . .	3,333	150,000	45
Brockton, . .	35,513	1,059,000	30	Framingham, . .	9,622	322,000	33
Brookline, . .	17,788	1,382,000	78	Franklin, . .	5,258	173,000	33
Cambridge, . .	86,289	6,658,000	77	Gardner, . . .	9,485	539,000	57

Statistics relating to the Consumption of Water in Various Cities and Towns — Concluded.

City or Town.	Population. 1897.	Average Daily Consumption. Gallons. 1897.	Daily Consumption per Inhabitant. Gallons. 1897.	City or Town.	Population. 1897.	Average Daily Consumption. Gallons. 1897.	Daily Consumption per Inhabitant. Gallons. 1897.
Gloucester, . .	29,635	834,000	28	Norwood, . .	4,910	354,000	72
Grafton, . . .	5,141	85,000	17	Orange, . . .	5,678	138,000	24
Holliston, . .	2,758	37,000	14	Peabody, . .	10,647	935,000	88
Hopkinton, . .	2,542	26,000	10	Provincetown, .	4,520	125,000	28
Hyde Park, . .	12,480	714,000	57	Quincy, . . .	22,308	1,250,000	56
Ipswich, . . .	4,832	88,000	18	Randolph and Holbrook.	5,821	279,000	48
Lawrence, . .	55,168	3,107,000	56	Reading, . . .	4,969	143,000	29
Longmeadow, .	624	48,000	77	Revere and Winthrop.	12,903	1,001,000	78
Lowell, . . .	87,035	6,594,000	76	Rockport, . .	5,770	170,000	29
Lynn and Saugus, .	69,831	4,642,000	66	Rutland, . . .	977	16,000	16
Malden, . . .	32,380	1,461,000	45	Salem, . . .	35,942	2,231,000	62
Manchester, . .	1,910	149,000	78	Sharon, . . .	1,750	40,000	23
Mansfield, . .	3,838	110,000	29	Stoughton, . .	5,440	211,000	39
Marblehead, . .	7,459	321,000	43	Swampscott and Nahant.	4,142	428,000	103
Marlborough, . .	15,445	535,000	35	Taunton, . . .	27,782	1,250,000	45
Maynard, . .	3,246	84,000	26	Tisbury, . . .	990	30,000	30
Medford, . .	15,832	1,099,000	69	Wakefield and Stoneham.	15,169	666,000	44
Melrose, . . .	13,343	924,000	69	Walpole, . .	3,150	58,000	18
Middleborough, .	6,939	196,000	28	Waltham, . .	21,744	1,541,000	71
Milford and Hopedale.	9,031	606,000	67	Ware, . . .	7,780	237,000	31
Milton, . . .	6,014	134,000	22	Wareham, Onset Bay.	3,333	13,000	4
Montague, . .	5,963	415,000	70	Watertown and Belmont.	11,215	513,000	46
Nantucket, . .	2,915	83,000	28	Webster, . . .	8,106	275,000	34
Natick, . . .	8,692	375,000	43	Wellesley, . .	4,481	177,000	39
Needham, . .	3,701	183,000	50	Weston, . . .	1,728	29,000	17
New Bedford, .	61,058	5,676,000	93	Whitman, . .	6,265	168,000	27
Newburyport, .	14,794	549,000	37	Winchendon, . .	4,530	48,000	11
Newton, . . .	28,874	1,804,000	62	Woburn, . . .	14,450	967,000	67
No. Attleborough, .	6,516	164,000	25	Worcester, . .	104,411	3,320,000	32
North Brookfield, .	4,941	166,000	34				

Rainfall.

The rainfall for the year 1897 was 3.41 inches more than the normal. An excess of rainfall occurred in the months of May, June, July, August, November and December, while in the other months there was a deficiency; the greatest excess occurred in the month of July, when the rainfall was 7.86 inches, or 3.88 inches in excess of the normal for that month. The greatest deficiency occurred in October, when the rainfall was but 0.8 of an inch, or 3.19 inches below the normal for the month of October. The large amount of rainfall during the summer months caused a large flow in the streams during that portion of the year when the flow is usually smallest. The average rainfall in Massachusetts, as deduced from long continued observations in various parts of the State, is given in the following table, together with the rainfall for each month in 1897 and the departures from the normal: —

Month — 1897.	Normal Rainfall. Inches.	Rainfall. 1897. Inches.	Excess or Deficiency. 1897. Inches.	Month — 1897.	Normal Rainfall. Inches.	Rainfall. 1897. Inches.	Excess or Deficiency. 1897. Inches.
January,	3.88	3.81	—0.07	August,	4.31	4.70	+0.39
February,	3.63	2.51	—1.12	September,	3.34	2.14	—1.20
March,	3.97	3.03	—0.94	October,	3.99	0.80	—3.19
April,	3.30	2.89	—0.41	November,	4.10	6.52	+2.42
May,	3.69	4.55	+0.86	December,	3.60	4.67	+1.07
June,	3.31	5.03	+1.72	Total,	45.10	48.51	+3.41
July,	3.98	7.86	+3.88				

To show the condition of the streams or sources of water supply from which samples of water have been collected for analysis during 1897, the following tables are presented, which give the daily rainfall in inches at 9 stations scattered throughout the State: —

Daily Rainfall in Inches at Nine Places in Massachusetts, Geographically selected.

January, 1897.										February, 1897.									
Day of Month.	Ludlow.	Amherst.	Fitchburg.	Framingham.	Chestnut Hill.	Lawrence.	Salem.	Taunton.	New Bedford.	Day of Month.	Ludlow.	Amherst.	Fitchburg.	Framingham.	Chestnut Hill.	Lawrence.	Salem.	Taunton.	New Bedford.
1, . .	-	-	-	-	-	-	-	-	-	1, . .	-	-	-	-	-	-	-	-	-
2, . .	-	-	-	-	-	-	-	-	-	2, . .	-	-	-	-	-	-	-	-	-
3, . .	-	-	-	-	*	-	-	-	-	3, . .	-	-	-	-	-	-	-	-	-
4, . .	*	0.14	-	*	*	*	*	*	*	4, . .	-	-	-	-	-	-	-	-	-
5, . .	1.00	0.50	0.42	1.03	1.26	1.71	0.84	1.05	0.28	5, . .	-	-	-	-	-	-	-	-	-
6, . .	-	-	-	-	-	-	-	-	0.70	6, . .	*	*	-	*	*	-	-	*	-
7, . .	-	-	-	-	-	-	-	-	-	7, . .	0.80	0.56	0.39	0.70	0.59	0.84	0.45	0.83	0.32
8, . .	-	-	-	-	-	-	-	-	-	8, . .	0.10	*	-	0.05	0.02	-	-	*	-
9, . .	-	-	-	-	-	-	-	-	-	9, . .	-	0.09	-	-	-	-	-	0.08	-
10, . .	-	-	-	-	-	-	-	-	-	10, . .	-	-	-	-	-	-	-	-	-
11, . .	-	-	-	-	-	-	-	0.02	-	11, . .	*	-	-	-	-	-	-	-	-
12, . .	-	-	-	-	-	-	-	-	-	12, . .	0.40	0.63	1.07	1.15	*	*	*	*	1.48
13, . .	-	-	-	-	-	-	-	-	-	13, . .	-	-	-	-	1.26	0.70	0.79	1.00	-
14, . .	-	-	-	-	-	-	-	-	-	14, . .	-	-	-	-	-	-	-	-	-
15, . .	-	-	-	-	-	-	-	-	-	15, . .	-	*	-	*	-	-	-	*	*
16, . .	-	-	-	-	-	-	-	-	-	16, . .	-	0.11	0.08	0.09	0.02	0.13	0.07	0.08	0.22
17, . .	-	*	*	*	*	*	*	*	-	17, . .	-	-	-	-	-	-	-	-	-
18, . .	0.40	0.35	0.34	0.39	0.32	0.21	0.26	0.75	0.57	18, . .	-	-	-	-	-	-	-	-	-
19, . .	-	-	-	-	-	-	-	-	-	19, . .	-	-	-	-	-	-	-	-	-
20, . .	-	*	0.01	*	*	*	*	*	-	20, . .	-	*	-	*	-	-	-	*	-
21, . .	0.85	0.95	0.60	0.73	0.70	1.02	0.72	0.90	0.72	21, . .	0.10	0.10	0.31	0.10	0.13	0.29	0.11	0.25	-
22, . .	0.05	-	0.04	0.08	0.05	0.07	*	*	-	22, . .	0.85	*	*	*	*	*	-	*	*
23, . .	-	0.04	-	-	-	-	0.09	0.11	0.15	23, . .	-	1.03	0.57	0.76	0.77	0.70	0.64	0.76	0.50
24, . .	-	-	-	-	-	-	-	-	0.05	24, . .	-	-	-	-	-	-	-	-	0.01
25, . .	-	-	-	-	-	-	-	-	-	25, . .	-	-	-	-	-	-	-	-	-
26, . .	-	-	-	-	-	-	-	-	-	26, . .	-	-	-	-	-	-	-	-	-
27, . .	-	-	*	*	*	-	-	*	-	27, . .	-	-	-	-	-	-	-	-	-
28, . .	1.80	1.80	1.20	1.91	1.76	1.21	-	1.40	1.50	28, . .	-	-	-	-	-	-	-	-	-
29, . .	-	-	-	-	-	-	0.89	-	-										
30, . .	-	-	-	-	-	-	-	-	-										
31, . .	-	-	-	-	-	-	-	-	-										
Totals,	4.10	3.78	2.61	4.14	4.09	4.22	2.80	4.23	3.97	Totals,	2.25	2.52	2.42	2.85	2.79	2.66	2.06	3.00	2.53

* Precipitation included in that of following day.

Daily Rainfall in Inches at Nine Places in Massachusetts, Geographically selected — Continued.

March, 1897.

Day of Month.	Ludlow.	Amherst.	Fitchburg.	Framingham.	Chestnut Hill.	Lawrence.	Salem.	Taunton.	New Bedford.
1, . .	*	*	–	0.09	0.07	*	*	–	*
2, . .	0.20	0.19	0.18	*	*	0.12	0.06	–	0.04
3, . .	0.37	0.29	0.29	0.37	0.18	0.40	0.16	0.22	–
4, . .	–	–	–	–	–	–	–	–	0.19
5, . .	0.50	*	0.65	0.30	0.30	*	*	0.34	*
6, . .	–	0.65	–	–	–	0.54	0.28	–	0.37
7, . .	–	–	–	–	–	–	–	–	–
8, . .	–	–	–	–	–	–	–	–	–
9, . .	*	*	–	*	–	*	*	–	–
10, . .	0.17	0.20	0.02	0.05	0.05	0.11	0.06	0.14	0.07
11, . .	–	–	–	–	–	–	–	–	0.03
12, . .	0.30	0.17	0.15	0.32	0.15	0.32	0.13	0.12	0.13
13, . .	–	–	–	–	–	–	–	–	–
14, . .	0.13	0.38	0.36	0.43	0.36	0.50	0.48	0.47	0.50
15, . .	–	–	–	–	–	–	–	–	–
16, . .	–	–	–	–	–	–	–	–	–
17, . .	–	–	–	–	–	–	–	–	–
18, . .	–	–	–	–	–	–	–	–	–
19, . .	*	*	–	*	*	–	–	–	0.03
20, . .	0.80	*	0.47	*	*	*	*	*	0.79
21, . .	–	0.73	–	0.87	0.90	0.63	0.63	0.85	–
22, . .	–	–	–	–	–	–	–	–	–
23, . .	*	*	–	*	–	–	–	–	0.64
24, . .	0.80	0.70	0.54	1.00	1.07	1.13	*	0.80	–
25, . .	–	–	–	–	–	–	0.89	–	–
26, . .	–	–	–	–	–	–	–	–	–
27, . .	–	–	–	–	–	–	–	–	–
28, . .	–	–	–	–	–	–	–	–	–
29, . .	–	–	–	–	–	–	–	–	–
30, . .	–	–	–	–	–	–	–	–	–
31, . .	–	–	–	–	–	–	–	–	–
Totals,	3.27	3.31	2.66	3.43	3.08	3.75	2.69	2.94	2.79

April, 1897.

Day of Month.	Ludlow.	Amherst.	Fitchburg.	Framingham.	Chestnut Hill.	Lawrence.	Salem.	Taunton.	New Bedford.
1, . .	–	–	–	–	–	–	–	–	–
2, . .	–	–	–	–	–	–	–	–	–
3, . .	–	–	–	–	–	–	–	–	–
4, . .	*	*	–	–	–	–	–	–	–
5, . .	0.30	0.19	0.10	0.17	0.25	0.30	0.27	–	*
6, . .	0.10	0.06	–	0.03	–	0.02	0.02	0.77	1.12
7, . .	0.15	*	0.03	*	0.61	–	*	*	–
8, . .	*	0.19	0.05	0.46	*	0.19	0.52	0.12	–
9, . .	1.25	–	0.61	*	1.69	–	*	2.23	*
10, . .	–	1.38	–	1.62	–	0.96	1.51	–	2.68
11, . .	–	–	–	–	–	0.02	0.12	0.19	0.25
12, . .	–	–	–	–	–	–	–	–	–
13, . .	–	–	–	–	–	–	–	–	–
14, . .	–	–	0.06	–	–	*	0.01	0.07	–
15, . .	0.30	0.34	0.17	0.20	0.36	0.17	0.32	0.61	0.22
16, . .	–	*	–	–	–	–	–	–	–
17, . .	0.30	0.30	0.25	0.20	0.18	0.21	0.10	0.12	–
18, . .	–	–	–	–	–	–	–	–	–
19, . .	0.10	0.01	0.01	–	–	0.04	–	–	–
20, . .	–	–	–	–	–	–	–	–	–
21, . .	–	–	–	–	–	–	–	–	–
22, . .	–	–	–	–	–	–	–	–	–
23, . .	–	–	–	–	–	–	–	–	–
24, . .	–	–	–	–	–	–	–	–	–
25, . .	0.05	0.04	–	–	–	–	–	–	–
26, . .	0.08	–	0.04	0.07	0.04	0.05	0.02	0.03	–
27, . .	0.05	0.06	–	*	0.10	0.10	–	*	*
28, . .	0.07	–	0.03	0.10	–	–	0.06	0.06	0.03
29, . .	–	–	–	–	–	–	–	0.08	–
30, . .	–	–	–	–	–	–	–	–	–
Totals,	2.75	2.57	1.35	2.85	3.23	2.06	2.95	4.28	4.30

* Precipitation included in that of following day.

Daily Rainfall in Inches at Nine Places in Massachusetts, Geographically selected — Continued.

May, 1897.

Day of Month.	Ludlow.	Amherst.	Fitchburg.	Framingham.	Chestnut Hill.	Lawrence.	Salem.	Taunton.	New Bedford.
1, . .	0.02	-	-	-	-	-	-	-	-
2, . .	0.20	*	0.77	*	*	*	-	-	*
3, . .	0.25	0.44	0.20	1.09	1.00	0.50	1.27	-	2.15
4, . .	-	0.21	0.17	0.35	0.44	0.27	0.17	-	-
5, . .	-	-	-	-	-	-	-	1.80	0.36
6, . .	-	-	-	-	-	-	-	-	-
7, . .	-	-	-	-	-	-	-	-	-
8, . .	-	-	-	-	-	-	-	-	-
9, . .	-	-	-	-	-	0.02	-	-	-
10, . .	-	*	0.44	*	0.64	0.73	-	0.18	-
11, . .	0.20	0.17	-	0.64	-	-	*	-	0.07
12, . .	0.30	0.50	0.45	0.23	0.20	0.30	0.90	*	-
13, . .	1.85	1.36	1.49	0.68	0.40	1.34	0.29	0.69	0.25
14, . .	-	0.08	-	-	-	-	*	-	1.12
15, . .	-	0.04	-	-	-	-	0.16	0.15	-
16, . .	-	-	-	-	0.08	-	-	0.17	0.23
17, . .	-	-	-	-	-	-	0.06	-	-
18, . .	-	-	-	-	-	-	-	-	-
19, . .	-	-	-	-	-	-	-	-	-
20, . .	-	-	-	-	-	-	-	-	-
21, . .	0.20	0.03	0.01	0.19	0.17	-	-	0.12	*
22, . .	-	-	-	-	-	-	*	-	0.16
23, . .	-	*	-	-	-	-	0.22	-	-
24, . .	-	0.37	0.01	*	-	0.02	-	-	-
25, . .	0.95	0.69	0.68	0.66	0.93	0.77	-	0.70	0.51
26, . .	-	-	-	-	-	-	0.68	-	-
27, . .	*	0.20	0.24	*	-	*	-	-	-
28, . .	0.17	-	0.07	0.07	-	0.68	0.42	-	-
29, . .	-	-	0.01	-	0.03	-	-	-	-
30, . .	*	-	-	-	*	-	0.37	*	-
31, . .	0.60	0.15	0.32	0.55	0.51	0.21	0.35	1.16	1.22
Totals,	4.74	4.24	4.86	4.46	4.40	4.84	4.89	4.97	6.07

June, 1897.

Day of Month.	Ludlow.	Amherst.	Fitchburg.	Framingham.	Chestnut Hill.	Lawrence.	Salem.	Taunton.	New Bedford.
1, . .	-	-	-	-	-	0.01	0.02	-	0.01
2, . .	-	-	-	-	-	-	-	-	-
3, . .	-	0.02	0.14	*	-	-	0.02	-	-
4, . .	0.25	-	0.23	*	*	-	0.10	-	-
5, . .	0.60	0.36	0.27	*	0.41	-	0.21	-	-
6, . .	-	-	-	0.44	-	0.94	-	0.13	-
7, . .	-	-	-	-	-	-	-	-	-
8, . .	*	0.02	-	-	-	-	-	-	-
9, . .	2.00	3.95	1.91	*	*	*	*	*	0.07
10, . .	-	0.16	0.81	2.27	2.14	2.56	1.95	0.79	0.62
11, . .	-	-	-	-	-	-	0.09	-	-
12, . .	-	-	-	-	-	-	-	0.07	-
13, . .	0.22	0.22	0.24	0.18	0.31	*	*	*	0.60
14, . .	0.20	0.20	0.29	0.05	-	0.68	0.21	0.35	-
15, . .	-	-	-	-	0.32	0.33	0.24	-	-
16, . .	-	-	-	-	-	-	-	-	-
17, . .	0.02	-	-	-	-	-	-	-	-
18, . .	-	-	-	-	-	-	-	-	-
19, . .	*	*	-	-	-	-	-	-	-
20, . .	0.75	0.34	0.10	0.27	0.32	0.17	0.42	0.83	0.49
21, . .	-	-	-	-	-	-	-	-	-
22, . .	-	-	-	-	-	-	-	-	-
23, . .	-	-	-	-	-	-	-	-	-
24, . .	-	-	-	-	-	-	-	-	-
25, . .	0.09	-	-	0.35	0.10	-	0.02	-	-
26, . .	-	-	-	-	-	-	-	-	-
27, . .	-	-	-	-	-	-	-	-	-
28, . .	-	-	-	-	-	-	-	-	-
29, . .	*	*	*	*	-	*	-	*	-
30, . .	1.08	1.40	1.10	0.88	0.93	0.69	0.91	1.08	0.69
Totals,	5.21	6.67	5.09	4.44	4.53	5.38	4.19	3.25	2.48

* Precipitation included in that of following day.

Daily Rainfall in Inches at Nine Places in Massachusetts, Geographically selected — Continued.

July, 1897.									
Day of Month.	Ludlow.	Amherst.	Fitchburg.	Framingham.	Chestnut Hill.	Lawrence.	Salem.	Taunton.	New Bedford.
1,	–	–	–	–	0.05	0.09	0.03	–	–
2,	–	0.05	–	–	–	–	–	–	0.26
3,	–	–	–	–	–	–	–	–	–
4,	–	–	–	–	–	–	–	–	–
5,	–	–	–	–	–	–	–	–	–
6,	0.05	0.08	–	–	–	–	–	–	–
7,	*	0.13	1.36	–	–	–	–	–	–
8,	1.20	–	–	–	–	–	–	–	–
9,	–	–	–	–	–	–	–	–	–
10,	–	–	–	–	–	–	–	–	–
11,	–	–	–	0.04	0.05	–	0.07	0.20	0.11
12,	*	0.60	0.13	–	–	–	–	–	–
13,	*	4.94	3.89	*	0.38	*	*	–	0.37
14,	6.25	1.33	0.92	0.90	0.28	1.03	0.43	1.20	0.14
15,	0.30	1.18	–	–	–	–	–	–	–
16,	–	–	–	–	–	–	–	–	–
17,	–	0.09	–	–	–	–	–	–	–
18,	0.06	0.02	–	–	–	–	–	*	–
19,	–	–	0.08	0.10	–	–	–	0.45	0.34
20,	–	–	–	–	–	–	–	–	–
21,	*	0.03	0.02	–	–	–	–	0.06	0.36
22,	2.37	1.68	1.12	1.56	1.28	0.65	*	1.27	0.24
23,	0.38	0.47	0.03	0.08	–	0.05	1.26	–	–
24,	0.44	0.22	2.38	1.05	0.58	0.15	0.73	0.54	0.15
25,	0.07	–	1.14	0.07	0.02	–	–	–	–
26,	–	0.20	0.07	–	–	0.01	–	–	–
27,	–	–	–	–	–	–	–	–	–
28,	*	0.60	–	*	*	*	–	*	–
29,	1.95	2.25	1.31	1.40	1.74	0.99	1.87	1.93	1.88
30,	–	–	–	–	–	–	–	–	–
31,	0.05	–	0.23	0.14	–	0.05	0.37	0.04	–
Tot.,	13.12	13.87	12.68	5.34	4.38	3.02	4.76	5.69	3.85

August, 1897.									
Day of Month.	Ludlow.	Amherst.	Fitchburg.	Framingham.	Chestnut Hill.	Lawrence.	Salem.	Taunton.	New Bedford.
1,	–	–	–	–	–	–	–	–	–
2,	–	–	0.20	–	–	–	–	–	0.03
3,	–	–	0.17	–	–	–	–	–	–
4,	*	*	–	*	0.38	0.12	*	–	–
5,	0.40	0.62	–	0.83	0.73	0.35	0.70	0.50	0.56
6,	–	–	0.29	–	–	–	–	–	–
7,	–	–	–	–	–	–	–	–	–
8,	–	–	–	–	–	–	–	–	–
9,	*	0.01	–	–	–	–	–	–	–
10,	0.15	0.22	0.10	–	–	–	–	–	–
11,	1.23	0.80	0.21	0.05	0.12	0.01	0.08	0.06	0.17
12,	0.04	0.02	0.08	–	0.06	–	–	–	0.12
13,	–	–	–	–	–	–	–	–	–
14,	*	–	–	–	–	–	–	–	–
15,	*	1.00	–	–	0.36	0.38	0.14	*	0.47
16,	1.05	0.09	0.26	0.61	0.14	0.32	0.56	0.64	4.60
17,	–	–	–	–	–	–	–	–	–
18,	0.30	0.04	–	0.06	1.00	–	0.42	0.91	–
19,	–	0.12	0.26	–	–	–	–	–	0.12
20,	–	–	–	–	–	–	–	–	–
21,	–	–	–	–	–	1.18	*	–	–
22,	–	0.70	–	0.48	0.62	–	0.42	0.27	0.90
23,	–	–	0.12	–	–	0.11	–	–	–
24,	0.95	0.70	–	0.92	1.27	0.82	*	1.77	1.60
25,	0.20	–	0.81	–	–	–	1.67	–	–
26,	–	–	–	–	–	–	–	–	–
27,	–	–	–	–	–	–	–	–	–
28,	–	–	–	–	–	–	–	–	–
29,	–	–	–	–	–	–	–	–	–
30,	–	–	–	–	–	–	–	–	–
31,	–	–	–	–	–	–	–	–	–
Totals,	4.32	4.32	2.50	2.95	4.68	3.29	3.99	4.15	8.57

* Precipitation included in that of following day.

Daily Rainfall in Inches at Nine Places in Massachusetts, Geographically selected — Continued.

September, 1897.									
Day of Month.	Ludlow.	Amherst.	Fitchburg.	Framingham.	Chestnut Hill.	Lawrence.	Salem.	Taunton.	New Bedford.
1, . .	-	-	-	-	-	-	-	-	-
2, . .	0.85	1.25	0.95	0.57	0.67	0.52	0.59	1.53	0.23
3, . .	-	-	-	-	-	-	-	-	-
4, . .	-	-	-	-	-	-	-	-	-
5, . .	-	-	-	-	-	-	-	-	-
6, . .	-	-	-	-	-	-	-	-	-
7, . .	0.05	-	-	-	-	-	-	-	-
8, . .	-	-	-	-	-	-	-	-	-
9, . .	-	-	-	-	-	-	-	-	-
10, . .	-	-	-	-	-	-	-	-	-
11, . .	0.03	-	0.03	0.05	0.15	0.11	-	-	-
12, . .	-	-	-	-	-	-	-	-	-
13, . .	-	0.05	0.16	0.04	0.34	0.24	0.16	0.04	0.04
14, . .	-	-	0.08	-	-	-	-	-	-
15, . .	-	-	-	-	-	-	-	-	-
16, . .	-	-	0.04	0.08	0.33	*	-	*	*
17, . .	-	0.16	-	-	-	0.18	-	0.39	0.04
18, . .	-	-	-	-	-	-	-	-	-
19, . .	-	-	-	-	-	-	-	-	-
20, . .	0.03	0.08	0.19	0.85	0.98	0.54	0.47	0.33	-
21, . .	-	-	-	-	-	-	-	-	-
22, . .	-	-	-	-	-	-	-	-	-
23, . .	0.50	0.14	-	*	*	*	-	*	*
24, . .	0.25	0.11	0.57	0.81	0.67	0.37	0.84	0.47	0.36
25, . .	-	-	-	-	-	-	-	-	-
26, . .	0.15	0.20	0.35	0.11	0.08	0.52	0.21	0.14	*
27, . .	-	-	-	-	-	-	-	-	0.21
28, . .	-	-	-	-	-	-	-	-	-
29, . .	-	-	-	-	-	-	-	-	-
30, . .	-	-	-	-	-	-	-	-	-
Totals,	1.86	1.99	2.37	2.51	3.22	2.48	2.27	2.90	0.88

October, 1897.									
Day of Month.	Ludlow.	Amherst.	Fitchburg.	Framingham.	Chestnut Hill.	Lawrence.	Salem.	Taunton.	New Bedford.
1, . .	-	-	-	-	-	-	-	-	-
2, . .	-	-	-	-	-	-	-	-	-
3, . .	-	-	-	-	-	-	-	-	-
4, . .	-	-	-	-	-	-	-	-	-
5, . .	-	-	-	-	-	-	-	-	-
6, . .	-	-	-	-	-	-	-	-	-
7, . .	-	-	-	-	-	-	-	-	-
8, . .	-	-	-	-	-	-	-	-	-
9, . .	-	-	-	-	-	-	-	-	-
10, . .	-	-	-	-	-	-	-	-	-
11, . .	-	*	-	*	-	0.14	-	*	*
12, . .	0.85	0.76	0.98	0.38	0.41	0.16	0.38	0.42	0.60
13, . .	-	-	-	-	-	-	-	-	-
14, . .	-	-	-	-	-	-	-	-	-
15, . .	-	-	-	-	-	-	-	-	-
16, . .	-	-	-	-	-	-	-	-	-
17, . .	-	-	-	-	-	-	-	-	-
18, . .	-	-	-	-	-	-	-	-	-
19, . .	-	-	-	-	-	-	-	-	-
20, . .	-	-	-	-	-	-	-	-	-
21, . .	-	-	0.05	0.03	0.12	-	0.05	0.55	0.76
22, . .	-	-	-	-	-	-	-	-	-
23, . .	-	-	-	-	-	-	-	-	-
24, . .	-	-	-	-	-	-	-	*	-
25, . .	-	-	-	-	-	-	-	0.11	-
26, . .	-	-	-	-	-	-	-	-	-
27, . .	-	-	-	-	-	-	-	-	-
28, . .	0.08	-	-	-	-	-	-	*	*
29, . .	-	-	-	-	-	-	-	0.05	0.06
30, . .	-	-	-	-	-	-	-	-	-
31, . .	-	-	-	-	-	-	-	-	-
Totals,	0.93	0.76	1.03	0.41	0.53	0.30	0.43	1.13	1.42

* Precipitation included in that of following day.

Daily Rainfall in Inches at Nine Places in Massachusetts, Geographically selected — Concluded.

November, 1897.									
Day of Month.	Ludlow.	Amherst.	Fitchburg.	Framingham.	Chestnut Hill.	Lawrence.	Salem.	Taunton.	New Bedford.
1, .	*	0.54	0.40	*	*	*	*	*	*
2, .	2.35	1.46	2.34	*	2.22	*	1.51	*	5.80
3, .	–	0.20	0.04	2.65	–	2.47	0.92	3.31	0.43
4, .	–	–	–	–	–	–	–	–	–
5, .	0.05	–	–	–	0.06	0.01	–	0.04	*
6, .	–	0.02	0.17	–	–	–	0.08	–	0.10
7, .	–	–	–	–	–	–	–	–	–
8, .	0.15	*	0.03	*	*	*	*	*	*
9, .	0.08	0.62	0.88	0.80	0.72	1.00	0.76	0.87	0.49
10, .	–	–	–	–	–	–	–	–	–
11, .	*	0.14	0.05	*	*	*	–	*	*
12, .	1.20	0.87	1.78	1.58	2.04	1.66	*	1.82	1.16
13, .	–	–	–	–	–	–	2.02	–	–
14, .	–	–	–	–	–	–	–	–	–
15, .	0.15	0.21	–	*	0.05	*	*	0.10	*
16, .	0.26	0.26	0.14	0.08	*	0.09	0.24	*	0.03
17, .	–	–	–	0.20	0.31	0.10	–	0.31	0.16
18, .	–	–	–	–	–	–	–	–	–
19, .	*	*	*	*	*	*	–	*	*
20, .	0.20	0.22	0.40	0.30	0.25	*	–	0.23	0.12
21, .	–	–	–	–	–	0.14	0.29	–	–
22, .	*	–	–	*	*	–	–	*	*
23, .	0.18	0.20	0.15	0.24	0.32	0.15	0.31	0.41	0.42
24, .	–	–	–	–	–	–	–	–	–
25, .	*	*	0.02	0.05	0.04	*	–	*	*
26, .	0.20	0.46	0.24	*	–	0.05	0.03	*	0.80
27, .	0.80	0.49	0.52	0.35	0.57	0.26	0.36	0.85	–
28, .	–	–	–	–	–	–	–	–	*
29, .	0.15	0.09	0.17	0.20	0.16	0.12	*	0.22	0.23
30, .	–	–	–	–	–	–	0.14	–	–
Tot.,	5.77	5.78	7.33	6.45	6.74	6.05	6.66	8.16	9.74

December, 1897.									
Day of Month.	Ludlow.	Amherst.	Fitchburg.	Framingham.	Chestnut Hill.	Lawrence.	Salem.	Taunton.	New Bedford.
1, .	–	–	–	–	–	–	–	–	–
2, .	–	–	–	–	–	–	–	–	–
3, .	–	0.09	0.04	0.06	*	0.02	*	*	*
4, .	*	–	0.10	*	0.05	*	0.06	*	0.09
5, .	0.90	0.97	0.64	0.38	0.37	0.62	0.42	0.56	0.60
6, .	–	–	–	–	–	–	–	–	–
7, .	0.10	0.05	0.11	*	*	*	*	*	*
8, .	–	0.04	–	0.15	0.13	0.19	0.33	0.17	0.20
9, .	–	–	–	–	–	–	–	–	0.02
10, .	–	–	–	–	–	–	–	0.04	–
11, .	–	*	–	–	–	*	–	–	–
12, .	0.60	0.66	0.63	0.42	0.42	0.32	0.36	0.60	0.56
13, .	–	–	–	–	–	–	–	–	–
14, .	*	*	1.53	*	*	*	*	*	*
15, .	2.80	4.09	1.65	2.90	2.48	2.10	2.10	2.22	1.88
16, .	0.20	–	–	–	–	–	–	–	–
17, .	–	0.02	*	0.04	0.03	0.02	*	0.02	*
18, .	–	–	0.03	–	–	–	0.03	–	0.03
19, .	–	–	–	–	–	–	–	–	–
20, .	0.06	0.11	0.21	0.23	*	*	*	*	*
21, .	–	0.07	–	–	0.20	0.20	0.22	0.25	0.43
22, .	–	–	–	–	–	–	–	–	*
23, .	–	–	–	–	–	0.06	0.02	–	0.05
24, .	–	–	–	–	–	–	–	–	–
25, .	–	–	–	–	–	–	–	–	–
26, .	0.09	0.06	0.09	0.18	0.21	0.13	0.20	0.35	*
27, .	–	–	–	–	–	–	–	–	0.32
28, .	*	–	–	–	–	–	–	–	–
29, .	0.07	0.12	–	0.10	0.05	*	–	*	*
30, .	–	–	0.14	–	–	0.06	0.05	0.14	0.18
31, .	0.95	0.70	1.22	0.60	0.56	–	0.60	0.23	–
Tot.,	5.77	6.98	6.39	5.06	4.50	3.72	4.39	4.58	4.36
Totals for the Year,	54.09	56.79	51.29	44.89	46.17	41.77	42.08	49.28	50.96

* Precipitation included in that of following day.

Flow of Streams.

The flow of the streams of the State during 1897, as indicated by the flow of the Sudbury River, was very nearly the average for the past twenty-three years. The flow was above the average in June, July, August and December, and below the average during the other months of the year. In order to show the relation between the flow of the Sudbury River during each month of 1896 and the normal flow of the same river as deduced from 23 years' observations, from 1875 to 1897, inclusive, the following table has been prepared. The area of the watershed of the Sudbury River above the point of measurement is 75.2 square miles.

Table showing the Average Monthly Flow of Sudbury River for the Year 1897, in Cubic Feet per Second per Square Mile of Drainage Area, also Departures from the Normal Flow.

Month.	Normal Flow. Cubic Feet per Second per Square Mile.	Actual Flow in 1897. Cubic Feet per Second per Square Mile.	Excess or Deficiency. Cubic Feet per Second per Square Mile.
January,	1.841	1.307	−0.534
February,	2.859	1.649	−1.210
March,	4.421	3.967	−0.454
April,	3.103	2.343	−0.760
May,	1.707	1.415	−0.292
June,	0.759	1.488	+0.729
July,	0.315	1.018	+0.703
August,	0.447	0.913	+0.466
September,	0.376	0.282	−0.094
October,	0.815	0.146	−0.669
November,	1.448	1.397	−0.051
December,	1.616	2.451	+0.835
Average,	1.637	1.540	−0.097

The next table shows the weekly fluctuations during 1897 in the flow of two of the streams, which are carefully measured, namely, the Sudbury and Merrimack. The flow of these streams, particularly the Sudbury, serves to indicate the flow of the other streams in eastern Massachusetts.

Week ending Sunday. 1897.	Sudbury River. Cubic Feet per Second per Square Mile.	Merrimack River. Cubic Feet per Second per Square Mile.	Week ending Sunday. 1897.	Sudbury River. Cubic Feet per Second per Square Mile.	Merrimack River. Cubic Feet per Second per Square Mile.
Jan. 3,	0.760	0.595	July 4,	0.679	1.290
10,	2.273	1.115	11,	0.088	0.991
17,	0.850	0.694	18,	0.442	4.396
24,	1.490	0.648	25,	1.532	2.214
31,	0.854	0.586	Aug. 1,	2.288	2.243
Feb. 7,	0.742	0.593	8,	1.621	1.459
14,	1.823	1.568	15,	0.471	0.997
21,	1.114	0.935	22,	0.744	0.878
28,	1.638	0.849	29,	0.843	0.971
Mar. 7,	3.434	1.140	Sept. 5,	0.583	0.731
14,	3.425	2.418	12,	0.342	0.589
21,	2.727	2.079	19,	−0.065	0.543
28,	5.901	3.355	26,	0.732	0.555
Apr. 4,	2.074	2.964	Oct. 3,	0.461	0.543
11,	3.840	4.618	10,	0.314	0.484
18,	2.693	4.225	17,	0.604	0.526
25,	1.326	3.394	24,	0.356	0.496
May 2,	1.088	2.815	31,	0.383	0.450
9,	1.722	2.309	Nov. 7,	1.310	1.110
16,	1.909	2.737	14,	1.426	1.274
23,	0.833	1.955	21,	1.226	1.388
30,	0.949	1.754	28,	0.905	1.103
June 6,	1.111	1.895	Dec. 5,	0.859	1.148
13,	3.210	4.526	12,	0.992	1.431
20,	1.352	3.297	19,	4.857	4.651
27,	0.571	1.801	26,	1.857	2.254

The following table gives the records of the rainfall upon the Sudbury watershed, and its total yield, expressed in inches in depth on the watershed (inches of rainfall collected), for the year 1897, together with the average of the records for the twenty-three years from 1875 to 1897, inclusive. The records of rainfall and rainfall collected for the preceding years may be found in the annual report of the State Board of Health for the year 1890, pages 338 to 340, the annual report for the year 1895, page 430, and the annual report for the year 1896, page 422.

Rainfall received and collected on the Sudbury River Watershed.

Month.	1897.			Mean for 23 Years, 1875-1897.		
	Rainfall.	Rainfall collected.	Per Cent. collected.	Rainfall.	Rainfall collected.	Per Cent. collected.
January,	4.005	1.507	37.63	4.227	2.123	50.22
February,	2.910	1.718	59.04	4.215	3.006	71.32
March,	3.660	4.575	125.00	4.381	5.097	116.34
April,	2.820	2.615	92.73	3.240	3.462	106.85
May,	4.370	1.632	37.35	3.420	1.969	57.57
June,	4.455	1.661	37.28	2.968	0.847	28.54
July,	5.445	1.174	21.56	3.782	0.363	9.60
August,	3.510	1.053	30.00	4.100	0.516	12.59
September,	2.935	0.315	10.73	3.229	0.421	13.04
October,	0.470	0.168	35.74	4.345	0.940	21.63
November,	6.405	1.570	24.51	4.185	1.616	38.61
December,	5.205	2.827	54.31	3.675	1.864	50.72
Totals and averages,	46.190	20.815	45.06	45.767	22.224	48.56

The Sudbury River records are particularly valuable as a basis for estimating the yield of other watersheds in Massachusetts, both on account of the accuracy with which the measurements have been made and the absence of abnormal conditions which would unfavorably affect the results. The following table gives the records relating to the yield of this watershed for each of the past twenty-three years, the flow from the watershed being expressed in gallons per day per square mile, instead of inches in depth of rainfall collected, in order to render the table more convenient for use in estimating the probable yields of watersheds used as sources of water supply.

*Yield of the Sudbury River Watershed in Gallons per Day per Square Mile.**

Month.	1875.	1876.	1877.	1878.	1879.	1880.	1881.	1882.
January, ...	103,000	643,000	658,000	1,810,000	700,000	1,121,000	415,000	1,241,000
February, ...	1,496,000	1,368,000	949,000	2,465,000	1,711,000	1,787,000	1,546,000	2,403,000
March, ...	1,604,000	4,435,000	4,813,000	3,507,000	2,330,000	1,374,000	4,004,000	2,839,000
April, ...	3,049,000	3,292,000	2,394,000	1,626,000	3,116,000	1,168,000	1,546,000	867,000
May, ...	1,188,000	1,139,000	1,391,000	1,394,000	1,114,000	514,000	965,000	1,292,000
June, ...	870,000	222,000	597,000	506,000	413,000	176,000	1,338,000	529,000
July, ...	321,000	183,000	202,000	128,000	158,000	177,000	276,000	86,000
August, ...	396,000	405,000	121,000	475,000	395,000	119,000	148,000	55,000
September, ...	207,000	184,000	60,000	160,000	141,000	80,000	197,000	306,000
October, ...	646,000	234,000	632,000	516,000	71,000	101,000	186,000	299,000
November, ...	1,302,000	1,088,000	1,418,000	1,693,000	206,000	205,000	395,000	210,000
December, ...	584,000	454,000	1,289,000	3,177,000	462,000	175,000	775,000	314,000
Average for whole year,	972,000	1,135,000	1,214,000	1,452,000	894,000	578,000	979,000	862,000
Av. for driest six months,	574,000	384,000	502,000	532,000	230,000	143,000	330,000	211,000

Month.	1883.	1884.	1885.	1886.	1887.	1888.	1889.	1890.
January, ...	335,000	995,000	1,235,000	1,461,000	2,589,000	1,053,000	2,782,000	1,254,000
February, ...	1,033,000	2,842,000	1,354,000	4,800,000	2,829,000	1,951,000	1,195,000	1,529,000
March, ...	1,611,000	3,785,000	1,572,000	2,059,000	2,868,000	3,237,000	1,339,000	3,643,000
April, ...	1,350,000	2,853,000	1,815,000	1,947,000	2,620,000	2,645,000	1,410,000	1,875,000
May, ...	938,000	1,030,000	1,336,000	720,000	1,009,000	1,632,000	880,000	1,366,000
June, ...	300,000	417,000	426,000	203,000	414,000	422,000	653,000	568,000
July, ...	115,000	224,000	62,000	115,000	114,000	117,000	633,000	108,000
August, ...	78,000	257,000	240,000	94,000	214,000	380,000	1,432,000	132,000
September, ...	91,000	44,000	121,000	118,000	111,000	1,155,000	824,000	458,000
October, ...	186,000	83,000	336,000	146,000	190,000	1,999,000	1,230,000	2,272,000
November, ...	205,000	175,000	1,178,000	673,000	368,000	2,758,000	1,941,000	1,215,000
December, ...	193,000	925,000	1,174,000	1,020,000	643,000	3,043,000	2,241,000	997,000
Average for whole year,	533,000	1,129,000	901,000	1,087,000	1,154,000	1,697,000	1,383,000	1,285,000
Av. for driest six months,	145,000	200,000	391,000	223,000	234,000	953,000	944,000	747,000

Month.	1891.	1892.	1893.	1894.	1895.	1896.	1897.	Mean for 23 Years, 1875-1897, inclusive.
January, ...	3,018,000	1,870,000	433,000	693,000	1,034,000	1,084,000	845,000	1,190,000
February, ...	3,486,000	943,000	1,542,000	991,000	541,000	2,676,000	1,067,000	1,849,000
March, ...	4,453,000	1,955,000	3,245,000	2,238,000	2,410,000	3,835,000	2,565,000	2,857,000
April, ...	2,397,000	871,000	2,125,000	1,640,000	2,515,000	1,494,000	1,515,000	2,006,000
May, ...	582,000	1,259,000	2,883,000	840,000	636,000	360,000	915,000	1,104,000
June, ...	414,000	428,000	440,000	419,000	174,000	399,000	962,000	491,000
July, ...	149,000	214,000	158,000	161,000	231,000	95,000	658,000	204,000
August, ...	163,000	280,000	181,000	209,000	229,000	57,000	591,000	289,000
September, ...	203,000	229,000	108,000	150,000	89,000	388,000	182,000	244,000
October, ...	210,000	126,000	221,000	374,000	1,379,000	592,000	94,000	527,000
November, ...	305,000	697,000	319,000	836,000	2,777,000	659,000	909,000	936,000
December, ...	544,000	485,000	797,000	716,000	1,782,000	657,000	1,584,000	1,045,000
Average for whole year,	1,315,000	781,000	1,037,000	770,000	1,152,000	1,019,000	991,000	1,057,000
Av. for driest six months,	239,000	327,000	237,000	356,000	456,000	314,000	564,000	402,000

* The area of the Sudbury River watershed used in making up these records included water surfaces amounting to about 1 per cent. of the whole area, from 1875 to 1878, inclusive, and subsequently increasing by the construction of storage reservoirs to about 3 per cent. in 1886. The watershed also contains extensive areas of swampy land, which, though covered with water at times, are not included in the above percentages of water surfaces.

EXPERIMENTS

UPON THE

PURIFICATION OF SEWAGE AND WATER

AT THE

LAWRENCE EXPERIMENT STATION,

DURING THE YEAR 1897.

EXPERIMENTS UPON THE PURIFICATION OF SEWAGE AND WATER AT THE LAWRENCE EXPERIMENT STATION.*

By Harry W. Clark, Chemist in Charge.

The year 1897 is the tenth that the investigations of the Lawrence Experiment Station have been continued. The work has been carried on under the general supervision of Hiram F. Mills, A.M., C.E., member of the State Board of Health, with the writer in direct charge.

This report is divided, as usual, into two parts: the first giving a full account for the year of all the work performed at the station upon the purification of sewage; and the second, a full account of the work for the year upon the purification of water.

Sewage Purification.

During the first seven years of operation of the station, all the studies upon sewage purification were made at the station and with Lawrence sewage drawn from one of the main sewers of the city. During the past three years, studies of the composition, volume and methods of disposal of waste liquor of various manufacturing industries in the State have also been made. Some of these studies have necessitated the operation of filters at places in the State where this manufactural sewage is produced, as enough of the liquor for experiments upon a suitably large scale could not conveniently be brought to the station.

Many of the problems, however, have been studied at the station with small filters, as it was considered that in some cases results obtained from these filters would show whether or no this manufactural sewage could be filtered and purified by the same processes which had been successful in the purification of ordinary city sewage. Moreover,

* A full account of the work done at the Lawrence Experiment Station for the years 1888 and 1889 is contained in a special report of the State Board of Health upon the Purification of Sewage and Water, 1890. A similar account for the years 1890 and 1891 is contained in the twenty-third annual report of the Board for the year 1891. Since 1891 the results have been published yearly in the annual reports.

these small filters could be attended to more carefully when under constant supervision at the station than larger filters at the manufacturing establishments, which we could visit only from time to time.

In the last report, results were published of studies and experiments with the sewage from two tanneries, two wool-scouring establishments and three paper mills. The waste liquor from these three industries has seemed to cause the greatest pollution of streams in the State, judging from observation and from applications to the Board in regard to pollution of streams.

Studies and experiments with the sewage of tannery No. 2, so called, have been continued through the year, and the studies and experiments upon the sewage of tannery No. 1 through the first three months of the year. Studies of paper-mill liquors and methods for their disposal, especially by rapid filtration through coke and cinders, have been continued, and also further investigation has been made in regard to the purification of wool-scouring liquor from the two plants previously noted, together with some interesting studies of the liquor from a third plant.

Tannery Sewage.

Tannery No. 1.

An extended study of methods of purifying the sewage from this tannery was made during 1896, and continued during the first three months of 1897. To give again a brief description, it can be said that the tannery is engaged in preparing and tanning calf skins, and two germicides are used in large quantities, the principal one being sulphide of arsenic, which is added to the liquor in the process of freeing the skins of hair. A ton or more of this chemical is used each month, mixed with lime to form a soluble salt of arsenic, and the sewage always contains a large quantity in suspension and in solution. It was found during 1897 that, by passing this sewage through a coke strainer, the arsenic could be removed quite completely from it, on account of the formation of a double insoluble salt of iron and arsenic, and that, after this preliminary straining, the sewage could be purified by filtration through sand by the same actions of nitrification and oxidation successful in the purification of ordinary sewage.

Three filters have been used in experiments upon the purification of sewage from this tannery: Filter No. 71, containing 4.5 feet in

depth of sand of an effective size of 0.23 millimeter, and receiving the sewage at a rate of 50,000 gallons per acre daily; Filter No. 72, a coke filter or strainer, receiving the sewage at the rate of 100,000 gallons per acre daily; and Filter No. 73, of the same depth and material as Filter No. 71, and receiving the effluent of Filter No. 72 at the rate of 100,000 gallons per acre daily. The following table gives the average analyses of the tannery sewage and the effluents of these three filters for the first three months of 1897, after which the filters went out of operation.

Average Analyses of Sewage applied to and Effluents from Filters Nos. 71, 72 and 73.

[Parts per 100,000.]

	Ammonia.		Chlorine.	Nitrogen as		Oxygen Consumed.
	Free.	Albuminoid.		Nitrates.	Nitrites.	
Sewage,	1.0900	4.7000	43.00	0.000	.0000	40.50
Effluent of Filter No. 71,	3.9833	0.9933	33.30	0.044	.0000	14.77
Effluent of Filter No. 72,	3.0667	0.8900	27.60	0.037	.0033	11.97
Effluent of Filter No. 73,	0.6947	0.1113	32.67	1.693	.0047	3.73

Tannery No. 2.

In place of the large sand filter which had been in operation at tannery No. 2 for eighteen months, and previously reported upon, a coke strainer of equal area has been in operation during 1897. It has been known for some time, and the results of experiments given in various reports of the Board show that city sewage can be strained through coke at a very rapid rate and a large percentage of the insoluble organic matters of the sewage, together with a small amount of the soluble organic matters can be removed. It was thought advisable to study the purification of the sewage of this tannery by a similar method, it being known that the very large amount of sludge which it contains, as shown by previous reports and also by the table beyond, rapidly clogged ordinary sand filters, and thus rendered it impossible to operate them at high rates. It had been learned from experiments that a considerable portion of this sludge precipitates on allowing the sewage to stand, and that the supernatant sewage can be purified by filtration through sand, but

there results from this method a very large amount of sludge liquor. If, however, the entire sewage could be passed through a coke strainer at a high rate, the sludge removed by the strainer would remain upon the surface of the coke, and could be scraped from the filter with a small proportion of coke, and burned. By this method, then, we would have no troublesome sludge liquor to be cared for.

This strainer, $\frac{1}{280}$ of an acre in area, was first put in operation in December, 1896. It contains 2 feet in depth of coke, the upper portion being coke breeze and the lower portion coarser coke. It has been operated during the year at rates varying from 250,000 to 300,000 gallons per acre daily, and has been entirely successful in caring for the applied sewage. At the rate given, it has removed about 85 per cent. of the crude organic matters of the applied sewage, represented by the determinations of albuminoid ammonia, and 83 per cent. of those represented by the determinations of oxygen consumed. This sludge has clogged the surface of the strainer several times during the year, and has had to be removed. While no experiment upon a large scale has been made upon the question of burning this deposit, considerable fat is contained in it, and this, together with the aid to combustion given by the coke removed with the sludge, as shown by a laboratory experiment, makes clear that it could be easily disposed of in this way.

The effluent of this strainer, even after the removal of so large a percentage of organic matter as shown by the figures above, is fully as strong as ordinary city sewage, but can be easily disposed of at a high rate upon ordinary sand filters. It is noticeable that, although nitrification has not taken place in the strainer, still its effluent is often fairly clear, and of a color easily read upon our color standards; while the applied sewage is always highly colored, either black, red or brown, according to the nature of the work being carried on in the tannery. The following tables give the monthly averages of the analyses of the sewage applied to and the effluent from this strainer: —

Sewage of Tannery No. 2.

[Parts per 100,000.]

1897.	Appearance.		Ammonia.			Chlorine.	Nitrogen as		Oxygen Consumed.	Fats.
	Turbidity.	Color.	Free.	Albuminoid. Total.	Albuminoid. Soluble.		Nitrates.	Nitrites.		
January, ...	Great.	Black.	3.73	3.46	2.25	273.5	.55	.0063	48.9	–
February, . . .	Great.	Black.	2.97	4.39	3.66	246.1	.42	.0060	30.1	–
March, ...	Great.	Purple.	1.22	0.70	0.39	161.0	.34	.0145	21.6	–
April, ...	Great.	Purple.	3.04	1.66	0.95	362.4	.23	.0210	89.7	–
May, ...	Great.	Purple.	2.70	4.02	2.30	328.5	.20	.0008	86.2	–
June, ...	Great.	Black.	5.92	4.86	3.02	549.5	.18	.0028	98.6	–
July, ...	Great.	.60	6.30	9.89	6.29	436.7	.13	.0500	171.4	18.13
August, ...	Great.	Black.	9.70	8.31	3.20	290.6	.13	.0000	73.3	42.80
September, . .	Great.	Brown.	9.00	9.36	5.99	407.2	.15	.0076	73.0	23.90
October, ...	Great.	Brown.	5.60	8.55	7.62	302.0	.24	.0100	56.0	8.70
November, . .	Great.	Brown.	3.68	5.31	3.00	390.0	.13	.0267	90.0	19.80
December, . .	Great.	Brown.	2.99	5.06	1.74	528.4	.37	.0007	170.6	50.20
Average, . .	Great.	–	4.74	5.46	3.37	356.3	.26	.0122	84.1	27.26

Effluent of Coke Strainer.

[Parts per 100,000.]

1897.	Appearance.		Ammonia.			Chlorine.	Nitrogen as		Oxygen Consumed.	Fats.
	Turbidity.	Color.	Free.	Albuminoid. Total.	Albuminoid. Soluble.		Nitrates.	Nitrites.		
January, ...	Great.	Brown.	3.07	2.1400	1.5300	262	.42	.0627	15.87	–
February, ...	Decided.	Black.	1.90	0.7700	0.6500	205	.77	.0170	5.33	–
March, ...	Great.	Black.	1.10	0.3800	0.3100	177	.48	.0185	7.63	–
April, ...	Great.	Black.	1.39	0.5800	0.4200	313	.17	.0740	13.70	–
May, ...	Great.	Black.	1.77	0.9500	0.6000	303	.13	.0228	17.04	–
June, ...	Decided.	Black.	0.98	0.4700	0.3200	295	.45	.8800	7.56	–
July, ...	Great.	.55	4.00	1.2100	0.8900	351	.06	.0193	29.53	8.07
August, ...	Great.	.90	1.68	1.6800	0.7700	407	.22	.3505	11.75	4.49
September, . .	Decided.	.71	1.89	0.8600	0.5500	364	.71	.2384	7.22	1.89
October, ...	Decided.	.68	2.20	0.4600	0.3200	310	.18	.1200	2.60	1.48
November, . . .	Great.	Black.	1.53	1.0400	0.7500	256	.15	.0287	9.10	3.27
December, . . .	Great.	.97	2.73	0.8200	0.4900	341	.25	.2375	24.05	6.33
Average, . .	–	–	2.02	0.9500	0.6300	299	.33	.1725	12.62	4.26

Sand Filter at Tannery No. 1.

The small sand filter containing 4 feet in depth of sand of an effective size of 0.15 millimeter, put into operation at the beginning of 1895, and receiving the supernatant sewage resulting from allowing the strong tannery sewage to stand for sedimentation to take place, has been continued in operation during the year. The rate of operation has been 30,000 gallons per acre daily during the year, and the filter has been in good condition, giving a fairly well-purified effluent. During cold weather, its effluent contained considerable nitrogen determined as albuminoid ammonia, owing to the fact that channels were formed upon the sides of the filter through which unpurified sewage passed; but nitrification continued exceedingly active, although the temperature of the building in which this filter is located approximates the temperature of the outside air. It will be seen from the table beyond that the quantity of fatty matters in the sewage applied to this filter are great when compared with those in ordinary city sewage, but they do not seem to remain in and clog the filter; in fact the fats retained by the filter for a time are destroyed by the bacteria, as in the filter receiving ordinary sewage, while much of the fatty matter seems to come through in the effluent. The following tables give the monthly averages of the analyses of the sewage applied to and the effluent from this filter: —

Supernatant Sewage of Tannery No. 2.

[Parts per 100,000.]

1897.	Appearance.		Ammonia.			Chlorine.	Nitrogen as		Oxygen Consumed.	Fats.
	Turbidity.	Color.	Free.	Albuminoid. Total.	Albuminoid. Soluble.		Nitrates.	Nitrites.		
January,	Great.	Brown.	4.70	1.17	0.93	217	.45	.0960	38.40	-
February,	Great.	Black.	6.68	1.41	1.20	395	.24	.0020	29.90	-
March,	Great.	Purple.	6.08	1.11	0.92	411	.27	.0160	71.00	-
April,	Great.	Brown.	3.19	0.70	0.57	195	.12	.0040	33.55	-
May,	Great.	Brown.	3.88	1.68	1.21	378	.08	.0072	64.52	-
June,	Great.	Black.	5.90	2.13	1.73	495	.10	.0000	102.75	-
July,	Great.	.90	9.00	3.35	2.37	206	.06	.0007	12.33	6.50
August,	Great.	-	11.00	2.64	2.18	625	.04	.0020	43.30	9.93
September,	Great.	Black.	8.46	3.18	2.32	459	.05	.0000	38.14	9.01
October,	Great.	Brown.	7.23	5.44	4.08	348	.13	.0067	31.00	6.35
November,	Great.	Brown.	8.81	2.40	1.81	450	.44	.0000	43.67	10.03
December,	Great.	Brown.	7.04	3.43	2.66	321	.11	.0000	51.40	12.00
Average,	Great.	-	6.82	2.39	1.83	375	.17	.0112	46.66	8.97

Effluent of Sand Filter at Tannery No. 2.

[Parts per 100,000.]

1897.	Appearance.		Ammonia.			Chlorine.	Nitrogen as		Oxygen Consumed.	Fats.
	Turbidity.	Color.	Free.	Albuminoid. Total.	Albuminoid. Soluble.		Nitrates.	Nitrites.		
January,	Slight.	.34	1.52	1.1600	.0960	250	11.42	.0233	1.67	-
February,	Decided.	.39	1.04	0.4618	.3975	301	12.12	.0185	1.31	-
March,	Decided.	.41	1.34	0.1290	.0930	413	9.22	.0198	0.98	-
April,	Decided.	.48	1.43	0.0625	.0565	346	5.81	.0103	0.88	-
May,	Decided	.53	1.32	0.0932	.0852	365	5.95	.0072	0.84	-
June,	Decided.	.52	1.60	0.0928	.0772	464	6.82	.0248	1.21	-
July,	Decided.	.44	0.77	0.1180	.0780	385	12.31	.0130	0.99	5.88
August,	Decided.	.66	1.40	0.1390	.0820	346	11.57	.0555	1.14	6.04
September,	Decided.	.72	0.93	0.1128	.0884	491	12.21	.0378	1.29	4.99
October,	Decided.	.41	0.87	0.0853	.0693	480	9.68	.0140	0.87	5.83
November,	Decided.	.58	1.89	0.1740	.1487	491	11.72	.0153	3.93	4.92
December,	Decided.	.58	1.91	0.1688	.1384	526	10.74	.0696	6.36	8.34
Average,	-	.51	1.45	0.2331	.1175	405	9.96	.0258	1.79	6.00

Filter No. 75.

The third filter, containing 4 feet in depth of sand of an effective size of 0.20 millimeter, receiving a mixture of this tannery sewage and Lawrence sewage in the proportion of one part of the former to three of the latter, has been continued in operation during the year, and has given, generally, a well-purified effluent. The reason of operating this filter is that it is sometimes necessary to care for a mixture of domestic and manufactural sewage upon one filtration area. The following tables give the monthly averages of the analyses of the sewage applied to and the effluent from this filter: —

Sewage applied to Filter No. 75.

[Parts per 100,000.]

1897.	Ammonia.		Chlorine.	Nitrogen as		Oxygen Consumed
	Free.	Albuminoid		Nitrates.	Nitrites.	
January,	3.92	1.11	68.2	.14	.0008	19.96
February,	4.08	1.54	76.6	.26	.0020	8.25
March,	4.03	1.19	82.0	.24	.0025	12.15
April,	3.35	1.04	70.6	.13	.0010	15.25
May,	3.76	1.73	129.6	.12	.0000	35.84
June,	6.80	3.13	102.5	.41	.0048	12.15
July,	4.50	2.42	346.8	.13	.0000	46.90
August,	3.88	2.78	170.8	.13	.0010	59.90
September,	4.85	3.03	85.5	.13	.0000	21.85
October,	7.45	3.72	97.2	.14	.0010	22.35
November,	4.80	2.75	112.4	.12	.0005	32.10
December,	3.00	2.41	126.0	.09	.0020	43.35
Average,	4.54	2.24	122.4	.17	.0013	27.50

Effluent of Filter No. 75.

[Parts per 100,000.]

1897.	Quantity Applied. — Gallons per Acre Daily for Six Days in a Week.	Temperature. Deg. F.		Appearance.		Ammonia.		Chlorine.	Nitrogen as		Oxygen Consumed.	Bacteria per Cubic Centimeter.
		Sewage.	Effluent.	Turbidity.	Color.	Free.	Albuminoid.		Nitrates.	Nitrites.		
January, . .	65,000	47	48	V. slight.	0.26	0.0350	.0440	78.8	2.43	.0013	0.41	14,100
February, . .	65,000	45	48	V. slight.	0.21	0.3395	.0495	75.0	3.56	.0861	0.44	8,000
March, . .	65,000	45	50	V. slight.	0.20	0.1587	.0420	63.4	3.54	.0703	0.33	21,200
April, . . .	65,000	47	57	Slight.	0.20	0.0220	.0448	86.4	2.70	.0013	0.32	-
May, . . .	65,000	58	64	Decided.	0.49	1.0195	.1925	119.5	0.35	.0288	2.85	104,000
June, . . .	51,600	63	66	Decided.	0.27	0.6350	.1860	93.8	1.44	.0410	4.34	30,800
July, . . .	29,300	72	76	Decided.	0.35	2.2400	.2150	269.0	2.62	.0230	1.47	40,250
August, . .	32,500	71	72	Slight.	0.33	0.0333	.0707	208.6	1.59	.0003	0.85	7,700
September, .	32,500	67	67	Slight.	0.50	0.0233	.1320	97.9	0.81	.0003	1.30	23,300
October, . .	25,300	57	62	Decided.	1.20	0.5930	.2510	96.1	1.64	.0000	1.59	19,500
November, .	25,300	47	52	Slight.	0.55	0.0640	.0890	121.0	3.50	.0075	1.01	2,200
December, . .	16,200	45	47	Slight.	0.46	0.0425	.0810	132.7	2.15	.0045	1.01	2,100
Average, .	44,800	55	59	Slight.	0.42	0.4338	.1165	120.2	2.19	.0220	1.33	24,800

Waste Liquor from Paper Mills.

Investigations have been continued in regard to the nature of and feasible methods of purification of waste liquor from paper mills. These investigations show that, as before stated, these liquors can be divided into two classes, namely, those produced in washing and preparing the stock and those produced in making this stock into paper. The volume of the first class is much less than the volume of the second class, and contains a very much greater amount, volume for volume, of organic pollutions. On page 442 of the report of the Board for 1896 is given a table of analyses of waste water from the rotary boilers of paper mill No. 2, so called. The liquor is the waste resulting from boiling the stock — consisting largely at this mill of old ropes and bagging — in caustic lime. During 1897, liquor of this sort, but from a different paper mill, has been applied to sand filter No. 85 at the station. The analysis of this liquor for five months is given in a table beyond. The table shows that the liquor is much more polluted than the corresponding liquor from

paper mill No. 2, this being caused by the different and dirtier and more highly colored class of stock used in this third mill.

This liquor was applied to Filter No. 85, containing 4½ feet in depth of sand of an effective size of 0.23 millimeter, and the rate of application and the monthly averages of the analyses of the effluent are given in the second table beyond. On comparing these two tables it will be seen that the filter succeeded in removing only a small percentage of the organic matters present in this strong alkaline liquor. Nitrification was active in the filter during two months of the period of its operation, — August and September, — when the filter was receiving a liquor somewhat different and weaker than the average for the entire period. The applied liquor was very highly colored, and the effluent of the filter was also too highly colored to be read upon our ordinary color standards, except upon a few occasions.

This strong liquor forms but a small proportion of the total outflow of a paper mill; hence experiments upon filtering the entire mixed liquor have been been made, our analyses having shown that on account of the large volume of the entire outflow, and the carbonaceous rather than nitrogenous character of the polluting matters, some system of removing these pollutions by sedimentation and straining, rather than by filtration and nitrification, is probably the practicable method of procedure.

At paper mill No. 1, so called, strainers of coke and cinder have been operated during the year at high rates, and have resulted in removing from the applied liquor a very large proportion of the total organic pollutions. From January to July, inclusive, a coke strainer, containing about 1 foot in depth of coke, with coke breeze forming the upper portion, was operated at a rate approximating 850,000 gallons per acre daily. To this strainer was applied a liquor representing, as nearly as could be obtained under the circumstances, the average of the outflow of this mill. The character of this liquor is shown by a table beyond. An examination of the table makes clear that much the greater portion of the organic pollutions are carbonaceous rather than nitrogenous. It will also be seen that this waste is quite highly colored, and the color readings given were made with the supernatant liquor after the sludge had settled. A second table beyond gives the monthly averages of the analyses of the effluent of this strainer, showing that it has removed about 63 per cent. of the organic matter determined as albuminoid ammonia and 70 per

cent. determined as oxygen consumed. The color of this effluent has been much less than that of the applied liquor, and always easily determined upon our color standards.

From July through December the mixed liquor was applied to a cinder strainer of the same depth as the coke strainer, and, from a chemical point of view, with as good results. It apparently was impossible, however, to operate the cinder strainer at as high a rate as the coke strainer, as the cinders crumbled and clogged the pores of the strainer, while the coke retained its form and did not cause clogging by crumbling. With both of these strainers a large proportion of the matters removed from the liquor has accumulated directly upon their surfaces, forming a mat-like mass of paper and dirt, which has been rolled up and removed from time to time.

Sewage applied to Filter No. 85.

[Parts per 100,000.]

1897.	Ammonia.		Chlorine.	Nitrogen as		Oxygen Consumed.
	Free.	Albuminoid.		Nitrates.	Nitrites.	
July,	2.78	9.39	25.40	.13	.0125	76.00
August,	4.93	5.65	12.10	.13	.0010	28.80
September,	4.45	1.94	9.67	.10	.0013	3.83
October,	7.00	19.08	25.95	.15	.0009	141.76
November,	4.27	0.83	8.81	.16	.0038	4.30
Average,	4.69	7.38	16.39	.13	.0039	50.94

Effluent of Filter No. 85.

[Parts per 100,000.]

1897.	Quantity Applied. — Gallons per Acre Daily for Six Days in a Week.	Temperature. Deg. F.		Length of Time Sewage Remained on Surface. — Minutes.	Appearance.		Ammonia.		Chlorine.	Nitrogen as		Oxygen Consumed.	Bacteria per Cubic Centimeter.
		Sewage.	Effluent.		Turbidity.	Color.	Free.	Albuminoid.		Nitrates.	Nitrites.		
July,	71,000	72	78	13m.	Great.	-*	9.10	5.59	26.30	0.06	.0380	50.00	2,276,000
August,	71,000	71	70	4m.	Decided.	-*	5.17	3.06	15.39	3.57	.3500	14.70	826,000
September,	69,000	67	68	5m.	Decided.	0.52	0.68	0.19	12.08	6.02	.3200	1.10	222,000
October,	88,000	57	55	32m.	Decided.	-*	10.75	18.25	31.33	0.27	.0000	141.50	2,486,000
November,	60,000	47	54	16m.	Great.	2.20	7.30	0.59	8.69	0.08	.0290	2.36	46,000
Average,	78,000	62	65	15m.	Decided.	-	6.60	5.54	18.76	2.00	.1474	41.92	1,171,000

* Brown.

Sewage applied, 3 gallons of paper mill liquor plus 3 gallons of regular sewage, six times a week, July 15 to 18, experiment interrupted by freshet. Surface raked 3 inches deep once each week.

Waste Liquor from Paper Mill applied to Strainers.

[Parts per 100,000.]

1897.	Appearance.		Ammonia.			Chlorine.	Nitrogen as		Oxygen Consumed.	Hardness.
	Turbidity.	Color.	Free.	Albuminoid. Total.	Albuminoid. Soluble.		Nitrates.	Nitrites.		
January,	Decided.	0.42	.0233	.0860	.0360	1.02	.03	.0006	3.05	10.4
February,	Decided.	0.25	.0185	.0640	.0395	0.71	.02	.0006	2.13	1.8
March,	Decided.	0.25	.0233	.0520	.0353	0.56	.01	.0005	1.61	1.1
April,	Decided.	1.50	.0105	.0460	.0355	1.83	.01	.0000	1.60	6.3
May,	Decided.	1.55	.0100	.0680	.0500	0.48	.02	.0000	2.22	3.1
June,	Great.	Red.	.0173	.1060	.0760	0.70	.01	.0000	3.09	8.6
July,	Decided.	0.93	.0140	.0896	.0680	1.02	.01	.0000	2.67	5.8
August,	Great.	0.58	.0113	.1213	.0573	1.15	.01	.0000	2.81	7.7
September,	Great.	1.03	.0336	.2160	.0792	1.63	.01	.0000	3.86	10.3
October,	Great.	–	.0407	.2853	.1040	1.47	.01	.0011	7.20	8.0
November,	Great.	1.01	.0260	.1095	.0520	1.02	.01	.0013	3.15	2.9
December,	Decided.	1.37	.0192	.1064	.0508	1.35	.01	.0046	2.58	8.4
Average,	–	0.89	.0206	.1125	.0570	1.08	.01	.0007	3.00	6.2

Effluent of Coke Strainer.

[Parts per 100,000.]

1897.	Appearance.		Ammonia.		Chlorine.	Nitrogen as		Oxygen Consumed.	Hardness.
	Turbidity.	Color.	Free.	Albuminoid.		Nitrates.	Nitrites.		
January,	Decided.	0.57	.0100	.0547	.83	.011	.0016	1.45	10.9
February,	Slight.	0.38	.0063	.0193	.70	.012	.0013	0.40	10.7
March,	Decided.	0.31	.0077	.0318	.60	.003	.0001	0.75	12.8
April,	Slight.	0.40	.0080	.0327	.86	.006	.0000	0.51	9.7
May,	Decided.	1.90	.0060	.0560	.58	.010	.0000	1.62	14.7
June,	Decided.	0.80	.0107	.0567	.76	.009	.0009	1.01	9.3
July,	Decided.	0.50	.0225	.0360	.95	.001	.0001	0.56	14.6
Average,	–	0.69	.0102	.0410	.75	.007	.0006	0.90	11.8

Effluent of Cinder Strainer.

[Parts per 100,000.]

1897.	Appearance.		Ammonia.		Chlorine.	Nitrogen as		Oxygen Consumed.	Hardness.
	Turbidity.	Color.	Free.	Albuminoid.		Nitrates.	Nitrites.		
July,	Great.	Red.	.0140	.0500	0.60	.001	.0000	3.04	8.6
August,	Decided.	.55	.0073	.0451	1.03	.003	.0000	0.89	19.6
September,	Great.	.70	.0089	.0536	1.09	.003	.0000	0.75	19.2
October,	Decided.	.45	.0084	.0491	1.42	.006	.0000	0.82	15.4
November,	Decided.	.32	.0067	.0291	1.27	.005	.0000	0.48	16.1
December,	Slight.	.40	.0027	.0262	1.00	.007	.0001	0.51	16.2
Average,	-	.48	.0080	.0422	1.07	.004	.0000	1.08	15.9

Waste Liquors resulting from Scouring and Rinsing Wool.

The investigations in regard to the composition of the waste liquor from scouring wool, and also the liquor from rinsing the wool after scouring, have been continued throughout the year. Many analyses have been given in the last two reports, showing the nature of these two liquors, together with accounts of experiments upon their purification. The studies of the waste from the two wool-washing establishments, from which almost all the liquor experimented with has been taken, seem to make certain that, owing to the great pollution of this liquor, both with dirt, wool-fat and soap, the only economical way of caring for the liquor resulting from the scouring process is either by evaporation, or some form of chemical precipitation and separation of the fats from the precipitated sludge, or a separation of the fats by means of acid and subsequent filtration of the liquor. Probably, taking into account the comparatively large volume of the scouring liquor produced at an establishment of moderate size, the method of precipitation and separation would be most feasible. The sludge produced is heavy and abundant, rich in fatty matters and potassium carbonate, probably worth nearly or quite the cost of their production in the form of sludge and their separation from it.

As stated in previous reports the scouring liquor forms but a small portion of the total outflow of a wool-scouring plant, the principal portion being the waste liquor resulting from rinsing the wool after scouring, and this rinse liquor contains only a very small percentage

of the total amount of dirt washed from the wool. At one of the establishments we have experimented simply with the scouring liquor, and from the other have obtained the rinse liquor, although at times the samples obtained from the second plant have been quite strong, as the scouring waste is from time to time released into the drain receiving the rinse water.

Investigations previously made and reported upon showed definitely that it was impossible to filter the heavy scouring liquor, as it quickly clogged the surfaces of either coke or sand filters. It was also shown that, after the removal of the sludge and a large proportion of the fats by precipitation with calcium chloride, the supernatant liquor was still exceedingly strong in organic matters, and that while its clogging properties had been removed and it would pass readily through either sand or coke filters, this filtration changed it but little, as nitrification did not take place within the filters.

Experiments also recorded on page 456 of the report of 1896 showed that while there was a vigorous growth of bacteria in the strongly alkaline scouring liquor just as received from the vats, yet there was a more vigorous growth after this liquor had been neutralized by the addition of a certain amount of sulphuric acid, and that a still more vigorous growth resulted when, to the wool liquor, a small proportion of city sewage was added.

On page 447 of the same report a description of Filter No. 76, receiving this clarified and neutralized wool liquor, was given. It was found that nitrification would not take place until a certain amount of city sewage was applied with the wool liquor. This filter has been continued in operation throughout the year at an average rate of 74,000 gallons per acre daily. The applied sewage has been in the proportion of 1 part wool liquor to 5 parts Lawrence sewage, and the effluent has been a clear but quite highly colored liquid, containing high nitrates and also a considerable amount of unnitrified organic matter; in fact, the analysis of the effluent shows more organic matter present than is usually present in strong city sewage, but the effluent is clear, with little or no odor, and that not at all offensive, and, when kept in bottles in the laboratory for a long period of time, does not develop an odor.

The unnitrified organic matter is apparently of a kind which, while it does not remain in and clog the filter, still is not easily attacked by the air or bacteria, and hence appears in the effluent. Bottles containing mixtures of this effluent and Lawrence water in

differing proportions have stood for months in the laboratory with little change in composition or odor. The following tables give the monthly averages of the analyses of the sewage applied to and the effluent from this filter: —

Sewage applied to Filter No. 76.

[Parts per 100,000.]

1897.	Ammonia.		Chlorine.	Nitrogen as		Oxygen Consumed.
	Free.	Albuminoid.		Nitrates.	Nitrites.	
January,	3.98	1.27	209.1	.13	.0072	8.28
February,	4.15	1.41	228.0	.25	.0120	9.25
March,	4.70	2.48	262.8	.21	.0315	20.35
April,	4.10	1.84	176.1	.21	.0095	12.15
May,	6.40	2.34	223.2	.16	.0176	18.76
June,	8.27	3.51	229.7	.30	.0007	26.67
July,	9.40	6.52	332.0	.15	.0000	36.40
August,	4.20	1.80	264.0	.19	.0120	10.40
September,	4.20	2.02	274.5	.12	.0010	8.70
October,	6.92	2.15	292.2	.08	.0004	20.84
November,	9.35	5.53	306.5	.19	.0700	65.45
December,	6.75	6.10	389.0	.15	.0100	56.85
Average,	6.04	3.08	265.6	.17	.0143	24.51

Effluent of Filter No. 76.

[Parts per 100,000.]

1897.	Quantity Applied. Gallons per Acre Daily for Six Days in a Week.	Temperature. Deg F.		Appearance.		Ammonia.		Chlorine.	Nitrogen as		Oxygen Consumed.	Bacteria per Cubic Centimeter.
		Sewage.	Effluent.	Turbidity.	Color.	Free.	Albuminoid.		Nitrates.	Nitrites.		
January,	98,200	47	48	Slight.	0.86	0.2425	0.24	212.4	3.96	.0215	1.96	161,500
February,	98,200	45	48	V. slight.	0.85	0.1275	0.27	229.9	4.07	.0208	1.88	880,500
March,	91,300	45	50	None.	2.87	0.5333	0.93	323.0	4.62	.0413	8.40	2,647,000
April,	98,200	47	57	V. slight.	1.58	0.1320	0.41	206.1	4.75	.0284	3.80	483,000
May,	98,200	58	64	V. slight.	2.37	2.6933	0.86	222.5	1.53	.0600	6.48	455,000
June,	41,000	63	66	Slight.	3.25	1.6000	1.08	233.8	3.09	.0270	9.30	-
July,	39,500	72	76	Decided.	4.50	1.1000	1.84	309.0	9.12	.0400	13.20	345,000
August,	18,800	71	72	Decided.	5.60	0.1600	0.90	270.0	14.08	.0080	7.60	24,500
September,	98,200	67	67	Decided.	1.22	0.0833	0.22	287.3	6.74	.0073	2.27	36,000
October,	98,200	57	62	Slight.	2.10	0.1500	0.44	284.0	4.40	.0060	4.20	17,000
November,	64,000	47	52	Decided.	5.00	6.0500	2.43	275.0	0.14	.0030	31.40	641,000
December,	49,100	45	47	Great.	Brown.	12.0000	2.92	303.0	0.06	.0060	38.00	455,000
Average,	74,400	55	59	-	2.75	2.0727	1.05	263.0	4.71	.0224	10.71	558,700

Rinse Liquor and Filter No. 70.

A liquor representing the entire waste flowing from a wool-scouring plant has also been experimentally treated during the past two years. It is mainly the rinse liquor, but the waste liquor from the

scouring process flows from time to time into the same drain pipes as the rinse liquor. The filter receiving this waste contains $4\frac{1}{2}$ feet in depth of sand of an effective size of 0.23 millimeter, and when first put in operation its effluent was quite free from organic matter, but nitrification did not take place. When, however, a small proportion — about one-fifth — of city sewage was added to the applied liquor, nitrification became quickly established, and the character of the effluent much improved. The rate of filtration during the first seven months of 1897 was 120,000 gallons per acre daily. Such good results were obtained at this rate, and the applied dose was disposed of so readily that the rate was doubled. Following this change, nitrification was less active in the filter for a while; but the effluent still continued to be of an exceedingly good character, and the reduction in nitrification is apparently explained by the fact that for some reason, probably a change in the character of the wool being scoured at this plant, this rinse liquor contained less organic matter during these remaining five months of the year. Tables giving the monthly averages of the analyses of the liquor applied to and the effluent from this filter are here presented: —

Sewage applied to Filter No. 70.

[Parts per 100,000.]

1897.	Ammonia.		Chlorine.	Nitrogen as		Oxygen Consumed.
	Free.	Albuminoid.		Nitrates.	Nitrites.	
January,	2.8760	.5740	5.24	.07	.0027	3.44
February,	3.2500	.5675	4.71	.08	.0012	2.88
March,	2.9125	.6675	3.79	.09	.0015	2.98
April,	3.6000	.7200	3.62	.10	.0016	2.95
May,	3.5200	.7260	4.64	.09	.0009	2.82
June,	1.3450	.3765	3.62	.06	.0003	1.75
July,	1.1650	.3725	5.27	.04	.0002	2.00
August,	0.7375	.3350	3.05	.04	.0007	2.30
September,	1.8875	.5700	3.74	.08	.0004	2.00
October,	2.6100	.5300	5.68	.03	.0014	2.18
November,	1.0000	.2925	2.49	.03	.0024	1.95
December,	0.8125	.3275	4.08	.04	.0016	2.73
Average,	2.1430	.5049	4.16	.06	.0012	2.50

Effluent of Filter No. 70.

[Parts per 100,000.]

1897.	Quantity Applied. Gallons per Acre Daily for Six Days in a Week.	Temperature. Deg. F.		Length of Time Sewage Remained on Surface. Hours and Minutes.	Appearance.		Ammonia.		Chlorine.	Nitrogen as		Oxygen Consumed.	Bacteria per Cubic Centimeter.
		Sewage.	Effluent.		Turbidity.	Color.	Free.	Albuminoid.		Nitrates.	Nitrites.		
January,	120,000	48	41	8m.	Decided.	.36	.5300	.0630	5.03	1.63	.0208	.62	43,400
February,	120,000	48	42	5m.	Decided.	.39	.7575	.1010	6.29	2.08	.0390	.73	143,600
March,	120,000	50	44	9m.	Decided.	.28	.1607	.0681	5.87	2.25	.0191	.57	100,000
April,	120,000	57	48	7m.	Decided.	.38	.1140	.1027	6.44	3.12	.0287	.69	135,000
May,	120,000	64	56	6m.	Decided.	.36	.0870	.1080	6.94	3.27	.0100	.65	130,400
June,	120,000	66	62	11m.	Decided.	.30	.0056	.0429	3.36	2.10	.0036	.37	100,000
July,	107,000	76	71	9m.	Decided.	.37	.0310	.0746	5.39	2.12	.0036	.52	1,592,000
August,	138,000	72	69	10m.	Decided.	.38	.0094	.0462	1.98	0.42	.0000	.51	132,000
September,	240,000	67	66	1h. 34m.	Decided.	.42	.0254	.0302	1.52	0.29	.0050	.47	86,400
October,	240,000	62	60	3h. 38m.	V. slight.	.32	.4778	.0510	3.09	1.29	.1575	.54	106,400
November,	314,000	52	48	13m.	Slight.	.33	.0034	.0260	1.81	0.71	.0011	.48	14,400
December,	200,000	47	42	26m.	V. slight.	.37	.0033	.0296	1.74	0.47	.0004	.54	15,500
Average,	163,300	59	54	35m.	-	.36	.1838	.0619	4.12	1.65	.0241	.56	216,600

Five gallons of rinse water from a wool-scouring mill plus 1 gallon of regular sewage applied six times a week, January 1 to August 26; 2½ gallons of wool-scouring liquor plus ½ gallon of regular sewage, six times a week, August 27 to November 16; 2 gallons of wool-scouring liquor plus ½ gallon of regular sewage, twelve times a week, November 17 to December 31. July 15 to 18, experiment interrupted by freshet. Surface raked 3 inches deep once each week.

Waste Liquor from a Third Wool-scouring Plant.

During the last few weeks of the year waste liquor from the scouring process of a third plant has been examined. This waste is the liquor resulting from first treating the strong scouring liquor in settling basins, in order to allow the dirt to settle, and a further treatment with sulphuric acid to separate the fats. After this treatment, the resulting liquor is acid, and when applied to a sand filter would, of course, pass through without change, except a straining out of the insoluble impurities. When neutralized, good results have already been obtained by filtration through coal ashes, and it probably can be filtered through sand successfully, if nitrification can once be started within the filter.

City Sewage.

The investigations in regard to the composition of city sewage, and the best methods for its purification under varying conditions, have been continued throughout the year. These investigations have continued for ten years, and a large number of tables have been given in the various reports, showing the strength of the sewage experimented with at the station, the changes it undergoes during its passage through the sewer and pipe to the station, and, in several of the reports, analyses are given of series of samples of sewage taken either at disposal areas in the State, or from asylums or other institutions in the State in order to show the average strength of sewage in this State.

It has, of course, been recognized for years that the strength of the sewage varies in proportion to the amount of water consumption in the town, city or institution from which it is obtained, compared with the population of the town, city or institution, and the leakage of ground water into the sewers. The varying composition of the sewage, due to the length of time elapsing between the passage of the sewage into the sewers and its analysis, has also been well recognized and explained. As early as the report of 1893 comparisons were made of the sewage taken directly from the sewer with that pumped at the station after its passage through the 2½-inch pipe, 4,300 feet long, connecting the sewer and station, and experiments were begun to compare the results of purification by filtration of fresh sewage from the Lawrence Street sewer and the sewage as pumped at the station. Since then, no report has been published without experiments showing the difference between fresh and stale sewage, in the arrangement of its nitrogen contents by the division into free and albuminoid ammonia or free ammonia and organic nitrogen.

Attention has also been called repeatedly to the loss of carbonaceous matters, as shown by the difference in the determinations of the oxygen consumed by fresh or stale sewage.

An examination of the series of tables given on the following pages will show that the station sewage — as represented by the tables headed "Regular Sewage," "Sewage for Filters 1, 6, 9," etc. — contains about a part more free ammonia and half a part less albuminoid ammonia than the sewage taken directly from the Lawrence Street sewer and brought to the station for analysis; and it will

also be seen that the stale sewage contains not much more than half as much organic matter, shown by the determination of oxygen consumed, as the fresh Lawrence Street sewage (page 413). The Lawrence sewage applied to the experimental filters is drawn through a 2.5 inch pipe, 4,300 feet long, from the Lawrence Street sewer, at a point just below the main business street of the city and just above the entrance of wastes from the large mills. This sewer drains the streets, houses and stores of the most densely populated portion of the city. Large measuring tanks receive this sewage at the station, and from them it is run upon the different filters.

The sewage used at the station is pumped during the day-time, a large portion entering the pipe during the morning, between eight and twelve o'clock, and consequently is much stronger than the average sewage flowing in the sewer for the entire twenty-four hours.

Samples of Sewage collected for Analysis.

1. On at least four days in each week a bottle of sewage from one of the measuring tanks, and this is known as the regular sewage.

2. On each Thursday a sample from the Lawrence Street sewer, at the point where the pipe from the sewer to the station begins. These samples are collected in the morning, when the strong day sewage is flowing through the sewer.

3. A sample representing an average of all the sewage pumped on each Tuesday of the year.

4. Samples representing weekly averages of all the sewage applied to filters Nos. 1, 6 and 9 A.

5. On each Tuesday of the year a sample of the supernatant sewage, after allowing regular sewage to stand for four hours for sedimentation to take place.

6. On each Tuesday of the year a sample of the supernatant sewage, obtained by treating regular sewage with sulphate of alumina in the proportion of 1,000 pounds per 1,000,000 gallons, and allowing it then to stand and settle for four hours.

7. On each Tuesday of the year a sample of the sewage resulting from straining regular sewage through a 6-inch layer of coke breeze, at a rate of 1,000,000 gallons per acre daily.

Monthly Averages of Analyses of Regular Sewage Samples.

[Parts per 100,000.]

1897.	Temperature, Deg. F.	Free Ammonia.	Albuminoid Ammonia. Total.	Albuminoid Ammonia. Soluble.	Albuminoid Ammonia. Insoluble.	Chlorine.	Oxygen Consumed.	Bacteria per Cubic Centimeter.
January,	47	3.51	0.97	.46	.51	7.66	5.55	3,818,000
February,	45	3.25	0.76	.39	.37	7.01	3.49	4,502,000
March,	44	3.26	0.87	.41	.46	6.30	4.34	4,945,000
April,	46	3.70	0.73	.37	.36	7.38	3.36	5,894,000
May,	58	3.94	0.83	.38	.45	9.77	4.08	5,390,000
June,	62	3.66	0.73	.34	.39	9.32	3.10	5,122,000
July,	71	3.75	0.80	.34	.46	12.27	3.70	5,141,000
August,	71	4.26	0.75	.36	.39	10.04	3.62	4,931,000
September,	66	4.24	0.75	.35	.40	9.31	3.62	4,051,000
October,	57	5.77	1.02	.48	.54	10.94	4.57	6,496,000
November,	47	4.31	0.91	.41	.50	7.71	4.64	4,606,000
December,	45	2.16	0.47	.26	.21	4.01	2.73	2,204,000
Average,	55	3.82	0.80	.38	.42	8.48	3.90	4,758,000

Monthly Averages of Analyses of Sewage from the Lawrence Street Sewer.

[Parts per 100,000.]

1897.	Temperature, Deg. F.	Free Ammonia.	Albuminoid Ammonia. Total.	Albuminoid Ammonia. Soluble.	Albuminoid Ammonia. Insoluble.	Chlorine.	Nitrogen as Nitrates.	Nitrogen as Nitrites.	Oxygen Consumed.	Bacteria per Cubic Centimeter.
January,	50	2.91	1.26	.85	.41	10.18	.21	.0100	6.93	3,048,000
February,	52	3.20	1.10	.78	.32	10.45	.18	.0145	7.03	5,233,000
March,	51	2.70	1.22	.84	.38	8.00	.26	.0165	7.83	3,888,000
April,	53	3.36	1.21	.77	.44	9.37	.21	.0188	7.74	5,718,000
May,	61	2.40	1.07	.70	.37	22.28	.21	.0193	7.57	4,560,000
June,	63	3.35	1.49	.70	.79	20.72	.28	.0275	8.18	4,483,000
July,	68	2.91	1.25	.67	.58	21.26	.14	.0244	6.40	6,140,000
August,	70	3.09	1.13	.74	.39	13.66	.17	.0075	7.15	7,400,000
September,	68	2.88	1.09	.62	.47	12.77	.11	.0138	6.44	5,992,000
October,	67	4.10	1.48	.77	.71	11.13	.11	.0250	7.75	3,510,000
November,	57	4.03	1.47	.97	.50	10.05	.15	.0215	8.25	4,525,000
December,	55	3.36	1.35	.95	.40	10.50	.18	.0200	9.86	2,218,000
Average,	60	3.19	1.26	.78	.48	13.36	.18	.0182	7.59	4,726,000

Monthly Averages of Analyses of Average Sewage Samples.

[Parts per 100,000.]

1897.	Free Ammonia.	Albuminoid Ammonia.			Chlorine.	Oxygen Consumed.	Fats.
		Total.	Soluble.	Insoluble.			
January,	3.18	.79	.44	.35	5.78	5.28	7.42
February,	3.95	.73	.49	.24	6.80	8.33	4.50
March,	3.38	.65	.42	.23	7.33	3.08	4.80
April,	5.00	.97	.51	.46	8.56	4.70	3.00
May,	4.55	.99	.40	.59	7.48	4.55	1.58
June,	4.46	.88	.40	.48	10.60	3.38	2.06
July,	3.53	.69	.34	.35	12.53	2.67	3.27
August,	4.68	.87	.37	.50	14.47	3.66	2.52
September,	5.77	.82	.40	.42	16.16	4.53	4.76
October,	5.53	.99	.51	.48	9.50	4.17	12.90
November,	3.70	.77	.46	.31	6.96	4.75	6.70
December,	5.05	.97	.54	.43	8.81	5.48	6.75
Average,	4.40	.84	.44	.40	9.59	4.43	5.02

Monthly Averages of Mixed Samples representing all of the Sewage applied to Filters Nos. 1, 6, and 9 A.

[Parts per 100,000.]

1897.	Free Ammonia.			Albuminoid Ammonia.			Oxygen Consumed.			Chlorine.		
	Filter No. 1.	Filter No. 6.	Filter No. 9 A.	Filter No. 1.	Filter No. 6.	Filter No. 9 A.	Filter No. 1.	Filter No. 6.	Filter No. 9 A.	Filter No. 1.	Filter No. 6.	Filter No. 9 A.
January,	3.68	3.52	3.98	0.74	0.70	0.81	4.28	4.16	4.64	6.05	5.58	5.60
February,	3.75	3.23	3.46	0.82	0.62	0.69	3.15	2.85	3.40	7.55	4.85	7.02
March,	2.86	3.65	3.23	0.68	0.88	0.88	2.88	4.48	4.63	5.14	5.75	5.83
April,	3.80	3.80	4.18	0.98	0.97	0.99	4.05	4.35	4.53	6.75	5.12	4.36
May,	4.26	3.94	4.30	0.92	0.83	1.00	3.88	3.58	4.36	7.46	6.35	6.21
June,	3.95	3.55	3.90	0.78	0.82	0.77	3.50	3.45	3.40	6.95	7.73	8.43
July,	3.47	3.67	3.37	0.79	0.90	0.86	3.60	3.70	3.57	11.19	18.02	7.61
August,	3.85	4.08	3.95	0.71	0.76	0.81	3.18	3.43	3.80	6.26	7.43	9.29
September,	4.60	4.65	4.88	0.76	0.96	0.96	3.60	3.98	4.50	7.99	9.66	9.25
October,	6.16	6.14	6.08	1.03	1.11	1.01	4.24	4.70	4.34	10.74	11.12	9.80
November,	4.80	5.10	4.90	0.93	1.00	0.95	4.48	5.35	5.03	6.02	6.37	7.16
December,	3.14	2.88	2.51	0.48	0.50	0.48	3.20	3.38	2.83	4.28	4.24	4.09
Average,	4.03	4.02	4.06	0.80	0.84	0.85	3.67	3.95	4.09	7.20	7.69	7.05

Monthly Averages of Samples collected each Tuesday.

[Parts per 100,000.]

1897.	Temperature, Deg. F.	Free Ammonia	Albuminoid Ammonia. Total.	Soluble.	Insoluble.	Chlorine.	Oxygen Consumed.	Bacteria per Cubic Centimeter.
January,	49	4.38	1.21	.56	.65	12.10	8.40	6,183,000
February,	47	4.28	1.06	.52	.54	8.98	5.43	6,340,000
March,	46	3.72	1.05	.48	.57	7.65	5.38	6,700,000
April,	48	4.85	0.89	.48	.41	8.31	4.05	6,760,000
May,	58	3.85	0.80	.42	.38	5.51	3.95	4,443,000
June,	62	3.86	0.66	.38	.28	7.61	2.70	4,444,000
July,	72	4.00	0.87	.37	.50	17.84	3.58	4,368,000
August,	71	3.76	0.79	.36	.43	8.16	3.94	5,560,000
September,	66	4.48	0.81	.33	.48	8.44	3.75	3,325,000
October,	57	5.58	0.99	.38	.61	12.33	4.48	6,920,000
November,	47	3.62	0.93	.35	.58	7.60	4.40	5,400,000
December,	44	2.20	0.52	.28	.24	4.59	3.15	2,603,000
Average,	56	4.05	0.88	.41	.47	9.09	4.43	5,254,000

Monthly Averages of Analyses of Supernatant Liquid from Settled Sewage for Filter No. 13 A.

[Parts per 100,000.]

1897.	Free Ammonia.	Albuminoid Ammonia. Total.	Soluble.	Insoluble.	Chlorine.	Oxygen Consumed.	Fats.	Bacteria per Cubic Centimeter.
January,	4.25	.81	.58	.23	11.11	5.93	5.02	3,945,000
February,	4.43	.75	.54	.21	8.92	4.43	4.62	4,460,000
March,	4.13	.69	.52	.17	7.88	3.90	4.25	3,845,000
April,	4.60	.68	.48	.20	7.45	3.30	1.80	4,487,000
May,	4.30	.52	.36	.16	5.58	3.00	1.20	3,497,000
June,	3.54	.45	.28	.17	7.25	1.76	2.36	3,398,000
July,	3.40	.46	.30	.16	9.40	1.67	2.17	2,743,000
August,	3.60	.45	.33	.12	8.11	2.00	1.86	2,942,000
September,	4.40	.44	.29	.15	8.69	2.27	2.33	2,627,000
October,	5.20	.65	.45	.20	7.57	2.95	7.50	4,530,000
November,	3.33	.50	.36	.14	6.42	2.80	6.20	3,058,000
December,	2.20	.40	.29	.11	4.60	2.63	4.00	1,880,000
Average,	3.95	.57	.40	.17	7.75	3.05	3.94	3,451,000

Monthly Averages of Analyses of Sewage strained through Coke for Filter No. 14 A.

[Parts per 100,000.]

1897.	Free Ammonia.	Albuminoid Ammonia			Chlorine.	Nitrogen as		Oxygen Consumed.	Fats.	Bacteria per Cubic Centimeter.
		Total.	Soluble.	Insoluble.		Nitrates.	Nitrites.			
January,	4.23	.71	.54	.17	12.00	.06	.0023	5.13	4.25	2,165,000
February,	4.20	.60	.46	.14	8.84	.04	.0003	3.13	5.62	1,883,000
March,	4.58	.57	.48	.09	7.56	.05	.0028	2.77	3.75	2,135,000
April,	5.10	.59	.36	.23	8.79	.05	.0018	2.83	2.20	4,613,000
May,	4.33	.48	.33	.15	6.99	.05	.0010	2.63	-	1,863,000
June,	3.86	.36	.28	.08	8.42	.06	.0044	1.58	1.62	1,664,000
July,	2.70	.32	.24	.08	8.69	.09	.0070	1.13	1.34	1,297,000
August,	3.24	.38	.29	.09	9.75	.14	.0102	1.48	1.08	1,746,000
September,	3.77	.33	.26	.07	8.92	.13	.0123	1.70	3.47	1,423,000
October,	5.70	.60	.41	.19	10.53	.06	.0040	2.60	5.10	6,110,000
November,	4.23	.40	.28	.12	7.39	.08	.0033	1.95	3.42	1,595,000
December,	2.35	.24	.20	.04	4.49	.18	.0035	1.23	5.78	435,000
Average,	4.02	.47	.34	.13	8.53	.08	.0044	2.35	3.42	2,244,000

Monthly Averages of Analyses of Supernatant Liquid from Sewage treated with Sulphate of Alumina for Filter No. 19.

[Parts per 100,000.]

1897.	Free Ammonia.	Albuminoid Ammonia.			Chlorine.	Oxygen Consumed.	Fats.	Bacteria per Cubic Centimeter.
		Total.	Soluble.	Insoluble.				
January,	4.33	.64	.54	.10	11.93	5.18	4.15	1,698,000
February,	4.18	.53	.39	.14	8.87	3.25	4.10	2,145,000
March,	4.18	.44	.38	.06	8.02	2.53	2.72	977,000
April,	4.57	.47	.38	.09	7.32	2.20	1.27	2,310,000
May,	3.88	.39	.33	.06	5.33	3.45	0.65	1,915,000
June,	3.60	.30	.24	.06	7.81	1.34	1.60	1,246,000
July,	3.30	.37	.28	.09	9.17	1.27	1.40	2,033,000
August,	3.68	.35	.28	.07	8.02	1.60	1.32	2,245,000
September,	4.40	.34	.22	.12	8.51	2.33	2.00	1,743,000
October,	5.25	.43	.30	.13	7.33	2.15	3.80	2,730,000
November,	3.33	.32	.24	.08	6.52	2.00	4.32	1,053,000
December,	2.20	.23	.18	.05	4.57	1.58	4.90	458,000
Average,	3.91	.40	.31	.09	7.78	2.41	2.69	1,713,000

The work upon the purification of domestic sewage at the station can be divided into three classes: first, purification by means of intermittent filtration through sand filters, receiving the untreated sewage and operating at normal rates, such as have been found could be successfully followed without causing clogging in these filters; second, rapid filtration of sewage by different methods and through different materials, after a removal of a certain amount of the sludge; third, dependence upon the rapid oxidation or burning of sludge, either by forced aeration or some other method of introducing air into the filter.

The principal filters of the first class mentioned are filters Nos. 1, 2, 4, 5 A, 6, 9 A and 10. These filters are all $\frac{1}{200}$ of an acre in area, and all except filter No. 6 contain approximately 5 feet in depth of filtering material over gravel underdrains. Filter No. 6 contains 44 inches of filtering material. Filters Nos. 1, 2, 4 and 6 had, at the end of 1897, been in operation ten years; filters Nos. 5 A and 9 A, seven years; Filter No. 10, three and one-half years. Each filter, with the exception of Filter No. 10, is entirely underdrained with 6 inches of graded gravel, and all have an outlet into one of the buildings of the station.

During the first years of operation of the experiments these filters were, as has been stated in previous reports, operated in a way known not to be the most desirable, but thought necessary in order to determine to what extent the filter would care for itself without disturbance of the surface. On account of this the surface of some of the filters became clogged, and in 1893, as stated in the report of the Board for that year, the clogged upper layers of material were removed from several of the filters. Since that date, however, the filters have been cared for in a more systematic manner; that is, the surfaces have been dug over, spring and fall, to a depth of 6 inches, corresponding to what could be done by ploughing a large area, and also have been raked from time to time, corresponding to harrowing.

The materials in the filters differ in their physical characteristics, both in size of sand grains and in uniformity of size of grains; Filter No. 1 containing sand of an effective size of 0.48 millimeter; Filter No. 2, sand of an effective size of 0.08 millimeter, with two circular trenches of sand at its surface, 1 foot wide and 2 feet deep, containing coarser sand of an effective size of 0.19 millimeter; Filter No. 4 containing sand of an effective size of 0.04 millimeter; Filter No. 5 containing gravel stones of an effective size of 1.40 milli-

meters; Filter No. 6 containing 44 inches in depth of mixed coarse and fine sand of an effective size of 0.35 millimeter; Filter No. 9 A, sand of an effective size of 0.17 millimeter; and Filter No. 10, material exactly the same as that in Filter No. 6. Filter No. 10, however, has no underdrains underneath this body of sand, except just above and around the outlet pipe. The surface of this filter is also divided so that the fourth of the surface farthest removed from the outlet receives the entire application of sewage. The average rate of filtration maintained by these filters during 1897 has varied from 19,400 gallons per acre daily, with Filter No. 4, to 120,000 gallons per acre daily, with Filter No. 10.

Tables showing the character of the effluent of each filter for each month of the year are given beyond, together with details in regard to the operation of the filters. Summarizing the results, we can say that all have given effluents for 1897 equal, considering the strength of the applied sewage, to results obtained in previous years. The purest effluent has been obtained from the filter containing the finest sand and operated at the lowest rate, — Filter No. 4; the poorest effluent from Filter No. 5 A, containing the coarsest material in any of these large intermittent filters. Filter No. 2, operating at a rate twice as great as Filter No. 4, has given an effluent containing very little more organic matter than the effluent of Filter No. 4, and of nearly equally good appearance. Filters Nos. 1, 6, 9 A and 10 have given effluents of about equal quality, as shown by the chemical analyses, but the effluent of Filter No. 9 A has contained fewer bacteria than the effluent of any other of these four filters.

The color of the effluent of Filter No. 4, as read upon our color standards, has varied from .01 in December to .10 in March. The color of the effluent of Filter No. 2 has varied from .07 in September to .12 in March. The effluent of Filter No. 2 has been very slightly turbid during the months of February and April, and without turbidity during the rest of the year; and the effluent of Filter No. 4 has been clear, showing no turbidity during the entire year. The color of the effluents of filters No. 1, 6, 9 A and 10 has been about the same during the months from May to November inclusive, the highest color of the effluent of Filter No. 1 being .60 in January and December; of Filter No. 6, .56 in March; of Filter No. 9 A, .67 in January; and of Filter No. 10, .39 in January and February. The effluent of Filter No. 1 has been slightly turbid during the sum-

mer and more decidedly so during the winter months. The effluent of Filter No. 6 A has shown a very slight turbidity every month except August and September; the effluent of Filter No. 9 A every month except August, September and October; and the effluent of Filter No. 10, every month except August, September and October.

Since the present system of caring for the surfaces of these various filters has been followed no difficulty has been experienced in causing them to take the prescribed amount of sewage during nine months of the year. During December, January and February, however, considerable difficulty is at times experienced. This varies with the temperature of the air, with the condition of the filters and with the kind of material in the filters. During the past four years an average of 4 inches of ice has been removed annually from Filter No. 1; $7\frac{1}{2}$ inches from Filter No. 2; 8 inches from Filter No. 4; 15 inches from Filter No. 5 A; 11 inches from Filter No. 6; 10 inches from Filter No. 9 A; and 5 inches from Filter No. 10. It will be seen that Filter No. 1, containing the coarsest sand, with the exception of Filter No. 5 A, disposes of its sewage the most easily during the winter months, very little remaining and freezing upon its surface. The high average for Filter No. 5 A is caused by a large amount of ice removed in the winter of 1894, when the filter was in poor condition, its surface being clogged and not disposing of the applied sewage. The amount removed from filters Nos. 2 and 4 is much less than would be the case if the sewage was applied to the entire surface of these filters instead of to the surface of the trenches, the surface of these trenches being lower than the rest of the surface of the filter, and the method of applying all the sewage to a small area of the filter concentrates the warmth of the sewage. From the surface of Filter No. 10 only one-half as much ice had to be removed as from the surface of Filter No. 6, although the material in these two filters is identical. The reason of this smaller amount removed from Filter No. 10 is that a greater volume of sewage is applied to a small area.

During 1897 the applied sewage remained upon the surface of Filter No. 1 but four minutes daily in July, and seven hours and thirty minutes in January; upon the surface of Filter No. 4, five minutes in July, and nine hours in January; upon the surface of Filter No. 5 A, five minutes in July, and one hour and forty-eight minutes in January; upon the surface of Filter No. 6, eleven minutes in July, and ten hours and twenty-four minutes in January; upon the surface of

Filter No. 9 A, nine minutes in July, and twenty hours and twenty-eight minutes in January; upon the surface of Filter No. 10, eleven minutes in July, and twelve hours and fifty-three minutes in January. These figures make plain that, at the rates employed, the surface of the filter of material as coarse as that in Filter No. 1 is less likely to become frozen and rendered useless by accumulated ice than a filter of a material similar to that in Filter No. 9 A.

It is also interesting to note that the 4 inches in depth of sewage applied to Filter No. 10 disappeared from the surface nearly as rapidly as the 2 inches of sewage applied to the surface of Filter No. 6. During the winter of 1897–98 experiments in regard to keeping the surfaces of filters free from ice, and the upper layers of the filtering material free from an accumulation of frost, by means of applying large doses of sewage, are being made. This cannot be done as well on the small filters, entirely underdrained, as on the large filtration areas in the State, with underdrains 15 or 20 feet apart, because with the experimental filters a large volume of sewage may melt small places through the frost, and thus go to the underdrains through but a small section of the filter, an accident not likely to happen on the larger areas. The difficulties experienced in keeping small experimental filters in successful operation during severe winter weather are certainly as great as experienced in the operation of large filtration areas in the State.

Discussion of Methods for Rapid Filtration of Sewage.

The first method, that of filtration through gravel filters with the aid of a current of air drawn down through these filters, has been fully discussed in previous reports, especially upon pages 482 and 483 of the report for 1895, and upon pages 476 and 477 of the report for 1896. It was stated in both of these reports that the results obtained were quite remarkable and interesting from a scientific point of view, but it was exceedingly doubtful if the method would be successful in actual practice, owing to the cost of aeration, and the fact that, in spite of the excessive aeration, sludge accumulated within these filters and had to be removed from time to time, either by flushing it out or a removal of the entire filtering material and washing it. These filters were continued during the first eight months of 1897, for purposes of comparison with other rapid methods of filtration, and tables giving the results are presented upon page 440. The daily rate of application of the

sewage was less by 90,000 gallons per acre than the average rate for the previous years of operation of these filters. Notwithstanding this reduction in rate, however, both filters were again becoming badly clogged when the experiment was ended.

The second method, that of filtration through gravel filters with the current of air forced up through the filters, was experimented upon during 1895, 1896 and the first four months of 1897, tables showing the results for 1897 being given on page 448. The discussion of the method was given upon page 477 of the report of 1896, and tables showing the analyses of the effluents of the filters are given upon pages 503 and 504 of the same report. The conclusions in regard to the first method are equally applicable to this second method. In this method, one of the preliminary filters was constructed of coke breeze, but operated in the same manner as the gravel filter, and the results showed a greater removal of sludge from the applied sewage, owing to the character of the filtering material; that is, it was more irregular in shape and of a much rougher surface than the gravel, and therefore caught and held the organic matter in suspension in the sewage better, and prevented its passage through the filter; but the results obtained were not such as to give reason for believing that the method would be practicable upon a working scale.

Removal of Sludge by Sedimentation, followed by Filtration of the Supernatant Sewage through Sand.

Experiments in regard to the amount of sludge that can be removed from sewage by allowing it to stand for four hours have been continued since the beginning of 1892. The results obtained have differed from year to year, according to the strength of the sewage and the amount of insoluble organic matter in suspension in it. This investigation continued throughout 1897, and during the first two months of the present year (1898), and the results obtained are shown by the table on page 415. During the entire period covered by this investigation, with the exception of a portion of 1893, the supernatant sewage has been applied to a sand filter at the station. During 1892 it was applied to Filter No. 32 at an average rate of 185,000 gallons per acre daily, as shown upon page 447 of the report of the Board for that year. The effluent of this filter was of an entirely satisfactory character.

Upon Sept. 27, 1893, the application of this supernatant sewage to Filter No. 13 A was begun, the average rate of application for that year being 425,000 gallons per acre daily. During 1894 this filter was kept in operation, but the rate was reduced, it having been found that the capacity of the filter was being overtaxed at the rate at which it was operated during the three months at the end of 1893. Upon Jan. 1, 1894, the rate was put at 240,000 gallons per acre daily, and remained so until the first of May, 1894, when it was changed to 160,000 gallons per acre daily, and has so continued until the end of the experiment on Feb. 28, 1898. This reduction of rate from time to time was due partly to the fact that the first rates were too high to be maintained and partly because the regular sewage was growing stronger year by year, and as a result the supernatant sewage was stronger.

Since May, 1894, the filter has taken the applied sewage readily, and given a satisfactory effluent, as shown by the tables in the reports of the various years. It has been necessary, of course, to disturb the surface of the filter quite frequently, and allow it short periods of rest upon several occasions.

Analyses of the filtering material have been made from time to time and a study of these analyses shows that while there was an increase of stored nitrogen within the filter for a year or two, yet during the last two years of operation of the filter there has been little if any increase. In conclusion, it can be said that the results obtained from this filter show that it could probably be operated indefinitely at the rate maintained during the past three years.

Chemical Precipitation.

A portion of the regular sewage pumped at the station has been treated during 1897, as in previous years, with sulphate of alumina at the rate of 1,000 pounds per 1,000,000 gallons of sewage, and then allowed to stand for four hours for precipitation to take place. This treatment of the sewage has been followed day by day since Jan. 20, 1893, and the supernatant liquid resulting has been applied to Filter No. 19. The rate of filtration was 120,000 gallons per acre daily up to June 12, 1893, after which the rate was increased from time to time until it became 640,000 gallons on Oct. 23, 1893. This rate overtaxed the capacity of the filter, and, after a period of rest, the rate was reduced to 360,000 gallons per acre daily upon

Jan. 8, 1894. This rate also was found to be too high for satisfactory purification to take place, and, upon May 31 of that year, the rate was reduced to 200,000 gallons per acre daily, a rate of application which has continued until the end of the experiment upon Feb. 28, 1898. During all this period the effluent of this filter has been of a very satisfactory quality, as shown by the tables given in the reports of the Board for the various years. Examinations of the sand of the filter at different depths have been made from time to time, and the results show that the filter was as free from organic matter at the time of ending the experiment as it had been at any time during the past two or three years, and the evidence is conclusive that at this rate and receiving sewage of the strength applied, this filter could be continued in operation for an indefinite period of time.

Straining through Coke.

Both sedimentation and chemical precipitation, while removing a large percentage of the organic matter of the sewage from the chief portion of the liquid allowed to stand for sedimentation or precipitation, still result in producing a considerable volume of sludge liquor to be cared for in some manner. For this reason, a method which would result in separating as much organic matter from the entire body of the sewage as sedimentation or precipitation does from the main portion of the liquid would be desirable. Experiments made at the station during 1894 showed that a layer of coke could be used as a strainer in such a way that sewage could be passed through it at a high rate, and the insoluble organic matter would remain upon or near the surface of this coke strainer.

Since June 1 of that year a continuous experiment has been made with a coke strainer, followed by filtration of the strained liquid through sand and coke. This strainer has contained generally about 6 inches in depth of coke, and the sewage has been passed through it at the rate of 1,000,000 gallons per acre daily. The percentage removal of sludge by this operation has been given in the various reports of the Board. The results for 1897 show that, by straining through coke at the rate of 1,000,000 gallons per acre daily, 62 per cent. of the organic matters determined as albuminoid ammonia and 50 per cent. of that determined as oxygen consumed have been removed from the sewage.

Upon June 1, 1894, this strained sewage began to be applied to a sand filter which had previously been in operation. The rate of filtration was at the start 320,000 gallons per acre daily. On November 6 it was increased to 480,000 gallons per acre daily. This rate overtaxed the capacity of the filter, and on December 26 it was reduced to 320,000 gallons per acre daily, and this rate continued until January, 1896, when it was reduced to 280,000 gallons per acre daily, and continued at this rate during the year 1897. The table showing the monthly averages of the analyses of this strained sewage is given on page 416, and the table showing the analyses of the effluent of Filter No. 14 A, the sand filter to which it is applied, is given on page 444.

On page 448 is given a table showing the character of the effluent of a coke filter which also receives this strained sewage, — Filter No. 65. This filter has not been in operation as long as Filter No. 14 A, but the results obtained are exceedingly interesting, and seem to indicate that this material will care for the sewage at a greater rate than will a sand filter, and give satisfactory results.

Straining through Coke, followed by Double Filtration through Sand.

During the summer of 1897 a plan was submitted to the Board providing for the purification of the sewage of a public institution in the State by straining the sewage through coke, followed by double filtration through sand, the sand beds being so constructed that the sewage from the coke strainer, after passing through the first bed, would fall directly upon the second bed, placed underneath the first.

At this institution it was estimated that the volume of sewage to be cared for daily would be about 150,000 gallons. Upon October 27 and 28 a twenty-four hour series of samples of the sewage was taken, measurements being made of the total flow of sewage for the twenty-four hours, showing the volume on that day to be 141,000 gallons.

The rate of filtration proposed by the plan was about as follows: 100,000,000 gallons per acre daily when one compartment of the coke strainer was in use, and half this, or 50,000,000 gallons per acre daily, when both compartments were in use. Through the upper sand filter the rate would be approximately 4,800,000 gallons per acre daily when one compartment of this filter was in use, and half this rate when both compartments were in use. After passing through this sand filter, the rate of its effluent through the second

sand filter would be 3,600,000 gallons per acre daily with one compartment in use, and half this with both compartments in use.

It was thought desirable to make an experiment at the experiment station, using filters similar to those proposed in this plant, and such a set of filters was put in operation during the first part of September. The strainer was arranged with layers of coke of different sizes, its total depth being about 12 inches, and having for the top 3 inches rather fine pieces of coke that would not pass through a $\frac{1}{4}$-inch screen, but free from coke dust. Below this the coke was coarser, averaging about the size of a mixture of beans and marbles.

From this strainer the sewage passed to a sand filter containing 18 inches in depth of sand over gravel underdrains which was directly above a filter containing 12 inches in depth of sand over gravel underdrains. These depths being the same as proposed in the plan. The rate of filtration or straining through the coke strainer has been as follows: —

During September, ...	3,880,000 gallons per acre daily.
During October, ...	2,720,000 gallons per acre daily.
During November, ...	4,280,000 gallons per acre daily.

Operating at this rate, the strainer has removed on an average about 38 per cent. of the total organic matter of the applied sewage. This rate could probably have been increased to some extent, and still resulted in removing nearly the same percentage of the insoluble organic matter of the sewage, but was not increased, as the volume obtained at this rate was all that could pass through the sand filters.

After passing through this strainer the sewage was applied to the upper sand filter at the following rate: —

During September, ...	970,000 gallons per acre daily.
During October, ...	680,000 gallons per acre daily.
During November, ...	1,070,000 gallons per acre daily.

Operating at these rates, the filter removed but very little of the soluble organic matter of the applied sewage, and nitrification was very feeble. There was little reduction in the free ammonia of the applied sewage in passing through this filter, but a considerable reduction of the organic matter determined as oxygen consumed. The filter was flooded twenty-four days during September, twenty-three days during October, twenty-three days during November and seventeen days during December. The surface of the filter had to be raked

1 inch deep daily, and, notwithstanding this, upon October 11 it had become so badly clogged that in order to allow sewage to pass through the sand it had to be raked 3 inches deep daily. In spite of these rakings the filter has not been able to receive any sewage upon several days of each month, as that applied upon the day before has failed to pass from its surface. Upon November 5 the upper 3 inches of sand in the filter had become so badly clogged as to require their removal in order to keep the filter in operation. Twice subsequently to this the same depth had to be removed, and at the end of the experiment the sand remaining in the filter was very foul, owing to the accumulation of organic matter upon it, and clearly in a condition to do service but a short time longer.

The second sand filter, placed below this upper filter, was slightly larger in area than the upper one, and received the effluent from the first filter without difficulty during the entire period of its operation, its surface having been raked but once. The rate of operation of this filter in gallons per acre daily was 1,109,000 during September, 777,000 during October and 1,223,000 during November.

While the effluent of this filter has contained as an average 2.5 parts of free ammonia and .17 of a part of albuminoid ammonia during the period of its operation, nitrification has been active since the first few days after it began to be used. Its effluent can perhaps be considered to be of a fairly satisfactory character, but always has been turbid. The main advantage of this lower filter, — as shown during the period of operation, — over a single filter containing a depth of sand equal to the combined depth of the two sand filters, was not owing to the fact that the effluent of the upper filter was aerated to any great extent while dropping to the lower one, as stated in the plan, but that the sludge of the sewage, during most of the period, was almost entirely removed from it by the first filter before reaching the second filter, and nearly all the organic matter applied to this second filter was in solution, and hence did not cause a clogging of the filter's surface. As a result of this the pores of the lower filter were not held full of sewage, and whenever the surface was uncovered air was drawn into the filter.

When the surface of a single filter of this depth is clogged as badly as the surface of the upper sand filter was during the last portion of the period of its operation, it prevents the free access of air to the interstices of the filter, and hence, of course, prevents nitrification and purification from taking place within the filter:

That is to say, with this plant the upper sand bed acts as a strainer instead of a filter, and the organic matter of the sewage retained by it has to be removed by scraping, together with a large amount of dirty sand.

It is undoubtedly true, also, that although the lower sand filter in the experimental plant gave for three months a fairly well purified effluent, its rate of filtration was too great, considering the strength of the applied sewage, to continue to give this result. An examination of the table giving the analysis of the sewage from the institution shows that it is only one-half as strong as the average Lawrence sewage, but the rates at which the two sand filters have been operated have been less than one-half the rate at which it was proposed to operate the sand filters by the plan referred to. The coke strainer has been operated at only about one-thirtieth the proposed rate of the coke strainer at the institution, and it can be said here that it is impossible to pass sewage through coke at the rate proposed, if the coke is fine enough to remove any considerable percentage of the organic matter in the applied sewage. Tables and details in regard to the operation of these experimental filters are given on page 455.

The Use of Ashes and Cinders in Intermittent Filtration, and in the So-called Bacterial Filters.

In England, owing to the difficulty of obtaining sand of a suitable character for the purification of sewage by filtration, many other materials, such as coke, cinders, clinkers, finely divided coal, burnt ballast, etc., have been used. Of these materials, experiments with coke only had been made at the experiment station previous to 1896, when the use of ashes and cinders began to be investigated, and experiments in this line have been continued during 1897. The great production of this waste by cities and towns, and its little value for any purpose, together with its possible utilization in sewage purification at places where land of a suitable character cannot be found, makes the investigation of considerable practical value.

Four of these filters have been in operation: one made of the entire waste product from the combustion of hard coal, one the entire waste product from the combustion of soft coal, and the other two of only the cinders of hard coal, that is, the coarser portions freed from ashes. These filters are numbered 80, 81, 82 and 95. Nos. 80 and 95 are intermittent filters, and a description of them is given

on pages 449 and 457. Nos. 81 and 82, however, containing cinders only, are operated after the fashion of the so-called bacterial filters of England.

Filter No. 81 contains 4 feet in depth of cinders, and has had applied to it, during a large portion of the year, at the rate of 880,000 gallons per acre daily, sewage which has first been strained through a layer of coke at the rate of 1,000,000 gallons per acre daily. The method of operation of the filter has been as follows: the outlet is closed in the morning and the sewage applied in small doses at one-hour intervals until the pores of the filter are entirely filled, and its surface just covered with sewage. It is then allowed to stand full for two hours, after which the outlet is opened and the sewage allowed to flow from the filter slowly, taking about ten hours for complete draining. Then the filter is allowed to stand inoperative until the next morning.

Filter No. 82 contains 5 feet in depth of cinders, and is operated by a slighly different method than that employed with Filter No. 81. The sewage applied to this filter, moreover, has not received any treatment before its application, and goes to the surface of the filter in the following manner: across the filter, and about 18 inches above its surface, an iron pipe is placed, with small orifices extending along its lower half. This pipe is parallel to the filter's surface. The sewage is pumped to a tank, elevated above the surface of the filter, to which this delivery pipe is connected, and when the gate upon the pipe is opened the pressure of the sewage causes it to rush from the pipe with considerable force in a large number of broken streams, and by means of this scattering and the spraying caused by the sewage striking the surface of the filter, considerable air is introduced into the sewage; analyses at different times showing the presence of from 30 to 60 per cent. of the dissolved oxygen necessary for saturation. The rate of filtration maintained has been 533,000 gallons per acre daily.

The supposed advantage of filters operated in this way is that, owing to the coarseness of the material, the sewage enters easily and there is no accumulation of impervious scum upon the surface of the filter, air is introduced within the filter between each application of sewage, and the entire body of filtering material is brought in contact with the daily dose of sewage, instead of only a few inches in depth of the filtering material at the surface of the filter. The results obtained with these filters and high rates of application of

sewage have been, on the whole, as good if not better than the results obtained from the aerated gravel filters Nos. 15 B and 16 B, described in previous reports and mentioned in this. The results, also, have been obtained without drawing air through the filters by means of aspirators, as in the case of the gravel filters, and hence, if successful year after year, this would be a considerably more economical process of sewage purification than either the aerated filters or any other method yet studied.

The results obtained from filters Nos. 81 and 82 are given in detail on pages 450 and 451. By an examination of the table it will be seen how great a purification has been effected by the filters. They have not as yet, however, been in use long enough to show whether or not this high rate of filtration can be maintained year after year without seriously clogging the filters, and perhaps destroying their efficiency.

In this connection it is well to recall the fact that, beginning in 1894, Filter No. 21 A, containing 5 feet in depth of fine gravel having an effective size of 1.6 millimeters, was operated practically according to the methods employed during the past year and a half with Filter No. 81. The rate of filtration was, during the first year, about 480,000 gallons per acre daily. During 1895 the rate was 360,000 gallons per acre daily, and the filter became so badly clogged during February of this year that it was not operated for a period of six weeks, but air was continually drawn through it during this period. Clogging again occurred in August, and for two weeks the filter was not flooded. During 1896 the average rate of filtration was 344,000 gallons per acre daily, but the filter was gradually becoming clogged with accumulated organic matter notwithstanding this aeration, and during 1897 was so badly clogged that the experiment was brought to an end. It must be said, however, that the gravel differed from the cinders in having a smooth surface instead of a rough one, and that it was a much more compact material, with less opportunity for the admission of air than is the case with the cinder filters.

An interesting experiment, showing the exhaustion of oxygen from the air in this filter and the formation of CO_2 gas, during a period when the filter was not having sewage applied to it, follows.

Determination of CO_2 in Air from Filter No. 21.

From March 27 to May 26, 1897, no sewage was applied to this filter, and air was drawn through it constantly, except upon several

occasions noted on the table. The rate of aspiration employed changed the air in the pores of the filter about once every three hours. Determinations of the volume of carbonic acid gas in the air drawn from the filter and in the air in the station were made eighteen times during April and three times in May, with results given in the following table. The results show that, even at the end of this prolonged period of rest and aeration, the stored organic matter in the filter increased more than fourfold the CO_2 in the air drawn through its pores. Determinations of oxygen made showed an average of 20.12 per cent. present when the filter was being constantly aspirated, but less than 1.0 per cent. when aspiration was stopped for a few hours.

CO_2 in Air of Station and from Filter No. 21.

[Volumes per 10,000; saturated with moisture.]

Date — 1897.	Air in Station.		Air from Filter.		Remarks.
	Time.	CO_2.	Time.	CO_2.	
April 1, . .	2.15	-	2.15	17.97	Aspirating continually.
2, . .	3.40	8.89	3.50	35.87	Aspirating continually.
5, . .	3.00	8.56	2.45	130.09	Stood from Saturday night to Monday morning without aspiration.
6, . .	11.00	7.12	11.15	43.05	Aspirating continually.
7, . .	8.55	6.92	8.45	28.34	Aspirating continually.
8, . .	9.00	6.90	8.45	27.70	Aspirating continually.
9, . .	9.10	6.31	9.00	38.88	Aspirating continually.
10, . .	8.40	8.86	8.30	17.87	Aspirating continually.
12, . .	11.30	9.28	11.20	23.38	Aspirating continually.
13, . .	10.10	9.16	10.00	23.86	Aspirating continually.
14, . .	8.45	4.79	8.30	22.45	Aspirating continually.
15, . .	8.40	5.31	8.30	23.12	Aspirating continually.
16, . .	11.15	12.70	11.00	21.81	Aspirating continually.
20, . .	11.15	5.95	11.00	261.72	Aspirator shut off from Saturday noon to Tuesday morning.
21, . .	2.00	5.56	2.10	50.22	Aspirating continually.
22, . .	9.30	7.10	9.40	18.25	Aspirating continually.
23, . .	9.00	6.42	8.45	21.51	Aspirating continually.
27, . .	2.50	7.10	2.40	29.40	Aspirating continually.
May 3, . .	3.10	5.99	3.00	19.59	Aspirating continually.
14, . .	2.15	10.40	2.00	32.89	Aspirating continually.
26, . .	8.50	7.02	8.40	31.10	Aspirating continually.

Purification of Urine by Filtration through Sand or Ashes.

Urine is one of the component parts of all domestic sewage, and experiments have been made during the past year to show how great a proportion of the sewage could be urine and still be purified to some extent by the usual action of nitrification in intermittent filters. It was thought worth while, also, to see if there was any material difference in the value of sand and ashes in this particular investigation. For this purpose, two small cylinder filters were constructed, one containing $4\frac{1}{2}$ feet of sand of an effective size of 0.20 millimeter, and the other containing the same depth of a mixture of ashes and cinders.

These two filters were put in operation in May, and the sewage applied was 3 parts Lawrence sewage, pumped at the station, to 1 part urine. Upon May 27 the rate was reduced one-half, but the sewage applied was of the same proportional character. Upon and after July 19, to this dose was added 300 cubic centimeters of hay infusion, made by allowing hay to soak in water. Upon August 6 the daily application of sewage was still farther reduced and the proportion of hay infusion increased, and several other changes were made during the following months, as detailed on page 454.

During the first four months of operation nitrification did not start to any extent in either filter, although the nitrites were high in the cinder filter during the last part of August, the average for the month being 8 parts per 100,000, and of nitrates .77 of a part per 100,000. In the effluent of the sand filter there was only .4 of a part of nitrites per 100,000 as an average during this month, and practically no nitrates. During September the nitrites doubled, and the nitrates increased to nearly 3 parts; this was followed in October by a still greater increase, the nitrites averaging over 32 parts for the month, and the nitrates about 38 parts. With the beginning of cold weather nitrification became less active. With the cinder filter the nitrites increased regularly from August to September, the effluent containing 31 whole parts, on an average, during November. During this month, also, the nitrates were the highest for any period, there being nearly 2 parts in the effluent.

The average albuminoid ammonia in the applied sewage for the whole period was 15.92 parts. The effluent of the cinder filter contained 1.93 parts and the effluent of the sand filter, 4.73 parts albuminoid ammonia. It can also be stated that, for a considerable

portion of the period of operation of these filters during 1897 the ash and cinder filter removed a large proportion of the color of the highly colored applied sewage, as shown by the tables on pages previously mentioned, while the sand filter removed very little color.

Permanency of Sewage Filters.

The following table gives the period of service to date of the large experimental filters, together with the volume of sewage applied to them; while the second table beyond shows their efficiency, reckoned by percentages of removed organic matter and bacteria, during 1897.

Filter Number.	Date when Sewage was First Applied.	Actual Number of Gallons Applied, to Jan. 1, 1898.	Gallons per Acre.
1,	Jan. 10, 1888,	1,263,545	252,709,000
2,	Dec. 19, 1887,	618,268	123,653,600
4,	Dec. 19, 1887,	422,968	84,593,600
5 A,	Sept. 14, 1891,	795,170	159,034,000
6,	Jan. 12, 1888,	848,289	169,657,800
9 A,	Nov. 18, 1890,	848,682	169,736,400
10,	July 18, 1894,	151,310	30,262,000

Average Per Cent. of Albuminoid Ammonia, Oxygen consumed and Bacteria removed from the Sewage by the Several Filters, with Average Rates of Filtration, 1897.

Number of Filter.	Dimensions of Filters. Depth of Sand (Inches).	Mean Diameter (Inches).	Area in Fractions of an Acre.	Size of Sand. Effective Size in Millimeters (10 Per Cent. finer than)	Uniformity Coefficient.	Manner of Filling.	In Operation Since	Average Rate of Filtration (Gallons per Acre Daily) Six Days in a Week.	Average Per Cent. removed of Albuminoid Ammonia.	Oxygen Consumed.	Bacteria.
1, ...	63	200	$\frac{1}{200}$	0.48	2.4	Wet	Jan. 10, 1888,	62,000	91	88	99.39
2, ...	60	200	$\frac{1}{200}$	0.08	2.0	Wet	Jan. 19, 1887,	39,000	97	94	99.99
4, ...	60	200	$\frac{1}{200}$	0.04	2.7	Wet	Dec. 19, 1887,	19,400	98	97	99.99
5 A, ...	63	200	$\frac{1}{200}$	1.40	2.4	Dry	Sept. 14, 1891,	58,800	77	82	98.51
6, ...	44	200	$\frac{1}{200}$	0.35	7.8	Wet	Jan. 12, 1888,	60,500	93	88	99.75
9 A, ...	60	200	$\frac{1}{200}$	0.17	2.0	Dry	Nov. 18, 1890,	61,500	92	87	99.76
10, ...	60	200	$\frac{1}{200}$	0.35	7.8	Dry	July 18, 1894,	118,000	93	89	99.91
15 B, ...	60	20	$\frac{1}{20000}$	5.10	2.0	Dry	July 25, 1892,	355,000	86	80	95.76
16 B, ...	60	20	$\frac{1}{20000}$	5.10	2.0	Dry	July 25, 1892,	323,000	67	67	96.78
21, ...	60	20	$\frac{1}{20000}$	1.60	2.4	Dry	March 19, 1894,	217,500	89	86	98.30
66, ...	60	50	$\frac{1}{3000}$	5.10	2.0	Dry	March 10, 1896,	657,000	58	56	93.08
80, ...	60	20	$\frac{1}{20000}$	–	–	Dry	May 8, 1897,	96,700	96	95	99.91
81, ...	60	6	$\frac{1}{222000}$	–	–	Dry	Nov. 26, 1896,	882,000	77	73	88.86
82, ...	60	30	$\frac{1}{8900}$	–	–	Dry	Apr. 12, 1897,	543,000	71	69	89.05
88, ...	54	10	$\frac{1}{80000}$	0.17	2.0	Dry	July 20, 1897,	89,400	97	97	98.73
95, ...	60	20	$\frac{1}{20000}$	–	–	Dry	Oct. 7, 1897,	100,000	98	98	99.85

Work of the Filters for 1897.

The remainder of this report upon sewage filtration contains a description of all the filters in operation at the station during 1897 which have received sewage taken from one of the principal sewers of the city of Lawrence, together with tables of analyses showing the results obtained. Filters Nos. 1 to 10 inclusive are each $\frac{1}{200}$ of an acre in area, and are out of doors. The remaining filters are all within the buildings of the station, and of various depths and sizes, as will be stated with the description of each filter.

Filter No. 1.

Filter No. 1 contains 60 inches in depth of coarse sand of an effective size of 0.48 millimeter, and is $\frac{1}{200}$ of an acre in area. The filter has been operated during the year at an average rate of 62,000 gallons per acre daily, and has given a satisfactory effluent, as shown by the table below. The surface of the filter has been raked 1 inch deep each week, and spaded over 6 inches May 24, September 6 and November 17.

Effluent of Filter No. 1.

[Parts per 100,000.]

1897.	Quantity Applied. Gallons per Acre Daily for Six Days in a Week	Temperature. Deg. F. Sewage.	Temperature. Deg. F. Effluent.	Length of Time Sewage Remained on Surface. Hours and Minutes.	Appearance. Turbidity.	Appearance. Color.	Ammonia. Free.	Ammonia. Albuminoid.	Chlorine.	Nitrogen as Nitrates.	Nitrogen as Nitrites.	Oxygen Consumed.	Bacteria per Cubic Centimeter.
January,	60,000	50	40	5h. 13m.	Decided.	.60	2.1000	.1603	6.76	1.17	.0163	.99	80,000
February,	60,000	50	39	3h. 58m.	Decided.	.50	1.6800	.1175	6.88	1.60	.0320	.74	57,500
March,	60,000	47	41	39m.	Slight.	.27	0.6000	.0705	5.94	2.60	.0563	.38	17,300
April,	60,000	47	49	26m.	Slight.	.21	0.0289	.0441	6.66	3.18	.0083	.32	9,800
May,	60,000	57	59	22m.	V. slight.	.19	0.0182	.0376	7.89	3.60	.0014	.28	7,800
June,	60,000	62	63	6m.	Slight.	.19	0.0734	.0503	6.99	2.54	.0002	.27	45,000
July,	53,300	71	71	4m.	Slight.	.18	0.1299	.0425	9.57	3.59	.0003	.26	10,800
August,	60,000	70	75	5m.	Slight.	.17	0.1544	.0430	13.79	3.79	.0003	.29	17,200
September,	57,700	65	70	8m.	V. slight.	.18	0.1372	.0336	10.98	3.58	.0004	.24	26,100
October,	60,000	56	62	4m.	Slight.	.15	0.1198	.0320	10.77	3.49	.0005	.25	16,800
November,	60,000	47	49	25m.	Decided.	.25	0.5900	.0693	9.41	2.26	.0067	.49	24,500
December,	94,100	50	42	5h. 15m.	Decided.	.60	0.9700	.1358	4.67	1.12	.0194	.91	32,700
Average,	62,100	56	55	1h. 24m.	Slight.	.29	0.5502	.0697	8.36	2.71	.0118	.45	28,800

Sewage applied, 300 gallons six times a week from January 1 to December 5; 500 gallons six times a week from December 6 to December 31. July 15 to 18, experiment interrupted by freshet. During January, 17 inches of snow and 2⅝ inches of ice removed; during February, 10½ inches of snow and ½ inch of ice removed; during March, 3 inches of snow removed; during November, 3 inches of snow removed; during December, 8 inches of snow and ⅞ inch of ice removed.

Filter No. 2.

This filter contains 60 inches in depth of fine sand of an effective size of 0.08 millimeter, with two trenches, 1 foot wide and 2 feet deep, of medium sand of an effective size of 0.19 millimeter, the surface of these trenches being below the surface of the remainder of the filter, and to these trenches all the sewage is applied. The average rate of filtration for the year has been 39,000 gallons per acre daily, and the filter has been in good condition throughout the year, and has given a clear, bright and well-purified effluent. The surface of the trenches has been raked 1 inch deep each week, and they have been spaded over to a depth of from 6 to 8 inches on April 13, September 6 and November 17. During the summer months there was a vigorous growth of grass upon the surface of the filter, which undoubtedly helped, as shown in previous years, to remove nitrogen from the surface layers, and thus aided in preventing clogging. The following table gives the monthly averages of the analyses of the effluent: —

Effluent of Filter No. 2.

[Parts per 100,000.]

1897.	Quantity Applied. Gallons per Acre Daily for Six Days in a Week.	Temperature. Deg. F.		Length of Time Sewage Remained on Surface. Hours and Minutes	Appearance.		Ammonia.		Chlorine.	Nitrogen as		Oxygen Consumed.	Bacteria per Cubic Centimeter.
		Sewage.	Effluent.		Turbidity.	Color.	Free.	Albuminoid.		Nitrates.	Nitrites.		
January, .	40,000	52	41	7h. 30m.	None.	.10	0.7480	.0328	8.70	1.80	.0109	.32	621
February, .	40,000	51	40	5h. 56m.	V. slight.	.10	1.4200	.0400	6.76	0.79	.0350	.35	1,345
March, .	40,000	47	38	3h. 10m.	None.	.12	1.3550	.0305	6.70	2.08	.0320	.30	434
April, . .	40,000	47	46	3h. 31m.	V. slight.	.08	0.4400	.0273	5.30	2.92	.0073	.25	291
May, . .	40,000	57	55	19m.	None.	.11	0.0228	.0213	7.38	4.34	.0001	.21	84
June, . .	40,000	62	60	15m.	None.	.11	0.0032	.0183	7.13	3.44	.0000	.17	33
July, . .	33,300	71	69	7m.	None.	.10	0.0023	.0183	10.11	3.79	.0000	.16	11
August, .	40,000	70	71	50m.	None.	.10	0.0027	.0202	11.90	4.45	.0000	.18	20
September,	38,500	65	70	1h 43m.	None.	.07	0.0011	.0167	11.91	3.90	.0000	.17	23
October, .	40,000	56	63	1h. 41m.	None.	.09	0.0014	.0142	10.19	3.37	.0000	.15	19
November, .	40,000	48	51	2h. 16m.	None.	.08	0.0066	.0168	10.78	3.44	.0000	.19	9
December, .	37,000	47	45	7h. 23m.	None.	.09	0.2040	.0224	8.17	2.43	.0091	.24	8
Average,	39,100	56	54	2h. 53m.	None.	.10	0.3506	.0232	8.75	3.06	.0079	.22	242

Sewage applied, 200 gallons six times a week. July 15 to 18, experiment interrupted by freshet January 1, surface of trenches broken up with a pick to a depth of from 3 to 4 inches. August 6, cut grass and weeds on surface. During January, 18 inches of snow removed from surface and ⅞ inch of ice from trenches; during March, 3 inches of snow removed from surface; during November, 2½ inches of snow removed from surface; during December, 7 inches of snow removed from surface and 4⅝ inche of ice from trenches.

Filter No. 4.

This filter contains 60 inches in depth of fine river silt of an effective size of 0.04 millimeter, with two circular trenches, about 14 inches wide and 12 inches deep, of coarse sand of an effective size of 0.48 millimeter. The surface level of the trenches is a few inches lower than the surface of the remainder of the filter, and the sewage is applied to these trenches. The filter has been in good condition throughout the year, and has given a clear, bright and well-purified effluent. During the summer the surface of the main portion of the filter was covered with a heavy growth of coarse grass which was cut during August. The average rate of filtration for the year has been 19,400 gallons per acre daily. The surface of the trenches has been raked to a depth of 1 inch each week, and dug over to a depth of from 6 to 8 inches April 12, September 16 and November 17. The monthly averages of the analyses of the effluent are given in the following table: —

Effluent of Filter No. 4.

[Parts per 100,000.]

1897.	Quantity Applied. Gallons per Acre Daily for Six Days in a Week.	Temperature, Deg. F.		Length of Time Sewage Remained on Surface. Hours and Minutes.	Appearance.		Ammonia.		Chlorine.	Nitrogen as		Oxygen Consumed.	Bacteria per Cubic Centimeter.
		Sewage.	Effluent.		Turbidity.	Color.	Free.	Albuminoid.		Nitrates.	Nitrites.		
January,	18,500	52	45	9h. –	None.	.04	.0145	.0127	8.13	2.34	.0002	.10	38
February,	20,000	49	41	8h. –	None.	.05	.0636	.0281	5.78	0.99	.0005	.17	323
March,	19,300	49	41	3h. 26m.	None.	.10	.1476	.0278	4.87	1.10	.0018	.13	28
April,	20,000	46	47	1h. 19m.	None.	.02	.3233	.0280	5.74	2.25	.0070	.16	23
May,	20,000	57	56	18m.	None	.05	.1950	.0230	7.27	3.72	.0009	.14	19
June,	20,000	61	61	13m.	None.	.06	.0338	.0134	7.65	3.99	.0002	.09	6
July,	16,300	70	70	5m.	None.	.06	.0019	.0105	7.23	2.47	.0000	.10	28
August,	18,500	70	70	16m.	None.	.06	.0017	.0137	8.66	1.96	.0000	.12	48
September,	19,300	66	70	13m.	None.	.04	.0015	.0117	10.70	3.85	.0000	.11	26
October,	20,000	56	63	10m.	None.	.05	.0015	.0103	11.37	4.81	.0000	.09	62
November,	20,000	49	54	30m.	None.	.04	.0041	.0102	10.32	4.54	.0001	.08	3
December,	19,300	48	47	56m.	None.	.01	.0029	.0097	6.96	3.14	.0000	.08	9
Average,	19,400	56	55	2h. 2m.	None.	.05	.0660	.0166	7.89	2.93	.0009	.11	58

Sewage applied, 200 gallons three times a week. July 13 to 18, experiment interrupted by freshet. January 1, surface of trenches broken up with pick to a depth of from 3 to 4 inches. August 6, cut grass and weeds on surface. During January, 9 inches of snow removed from surface and 4½ inches of ice from trenches; during February, 11½ inches of snow removed from surface and 4 inches of ice from trenches; during March, 2½ inches of snow removed; during November, 2½ inches of snow removed; during December, 4½ inches of snow removed from surface and 1¼ inches of ice from trenches.

Filter No. 5 A.

This filter contains 60 inches in depth of fine gravel of an effective size of 1.40 millimeters, and has received sewage at the average rate for the year of 58,800 gallons per acre daily. The surface of the filter has been raked 1 inch deep each week, and dug over to a depth of 6 inches on September 6 and November 27. The following table gives the monthly averages of the analyses of the effluent of this filter: —

Effluent of Filter No. 5A.

[Parts per 100,000.]

1897.	Quantity Applied. — Gallons per Acre Daily for Six Days in a Week.	Temperature. Deg. F.		Length of Time Sewage Remained on Surface. — Hours and Minutes.	Appearance.		Ammonia.		Chlorine.	Nitrogen as		Oxygen Consumed.	Bacteria per Cubic Centimeter.
		Sewage.	Effluent.		Turbidity.	Color.	Free.	Albuminoid.		Nitrates.	Nitrites.		
January,	59,200	46	40	1h. 48m.	Decided.	.50	2.1733	.2253	8.89	1.21	.0587	1.21	161,000
February,	60,000	44	38	1h. 49m.	Decided.	.55	1.9300	.2210	6.71	0.86	.0775	1.22	135,500
March,	60,000	44	40	38m.	Decided.	.36	1.4500	.1670	5.84	1.59	.0850	0.86	94,400
April,	60,000	47	48	30m.	Decided.	.30	0.3633	.0833	6.40	3.82	.0280	0.50	64,000
May,	60,000	58	58	27m.	Decided.	.20	0.1393	.0688	13.84	4.38	.0075	0.41	41,600
June,	60,000	62	63	24m.	Decided.	.17	0.1968	.1612	8.80	3.50	.0011	0.63	30,600
July,	51,100	71	73	6m.	Decided.	.27	0.3500	.0707	10.63	3.51	.0077	0.42	89,300
August,	57,700	70	74	10m.	Decided.	.17	0.2827	.0416	11.65	3.39	.0012	0.28	30,200
September,	57,700	65	70	5m.	Decided.	.23	0.3208	.0519	10.74	3.45	.0010	0.40	49,300
October,	60,000	57	61	13m.	Great.	.25	0.5387	.0660	10.77	3.35	.0039	0.39	48,500
November,	60,000	48	48	31m.	Decided.	.23	0.8033	.1714	7.52	2.27	.0087	0.98	45,200
December,	60,000	46	43	57m.	Decided.	.44	1.5300	.1873	8.38	1.46	.0835	1.29	59,400
Average,	58,800	55	55	38m.	–	.31	0.8399	.1263	9.18	2.72	.0303	0.72	70,800

Sewage applied, 300 gallons six times a week. July 15 to 18, experiment interrupted by freshet. June 18, a trap 18 inches high was attached to effluent pipe. During January, 19 inches of snow and 2 inches of ice removed from surface; during February, 10½ inches of snow and ⅝ inch of ice removed; during March, 3 inches of snow removed; during November, 2½ inches of snow removed; during December, 7 inches of snow and 1¼ inches of ice removed.

Filter No. 6.

This filter contains 44 inches in depth of mixed coarse and fine sand of an effective size of 0.35 millimeter. It has been in good physical condition throughout the year, has disposed of the applied sewage readily and given an effluent of a satisfactory quality. The average rate of filtration for the year has been 60,500 gallons per acre daily. The surface of the filter has been raked 1 inch deep each

week, and dug over to a depth of 6 to 8 inches on April 12, September 6 and November 17. The following table gives the monthly averages of the analyses of the effluent: —

Effluent of Filter No. 6.

[Parts per 100,000.]

1897.	Quantity Applied. Gallons per Acre Daily for Six Days in a Week.	Temperature Deg. F.		Length of Time Sewage Remained on Surface. Hours and Minutes.	Appearance.		Ammonia.		Chlorine.	Nitrogen as		Oxygen Consumed.	Bacteria per Cubic Centimeter.
		Sewage.	Effluent.		Turbidity.	Color.	Free.	Albuminoid.		Nitrates.	Nitrites.		
January, .	60,200	52	39	10h. 24m.	Decided.	.52	1.4133	.1543	7.08	1.21	.1317	.87	49,000
February, .	60,200	49	37	1h. 51m.	Decided.	.52	1.3500	.0975	4.80	0.98	.0850	.67	20,200
March, .	60,000	48	42	1h. 33m.	Decided.	.56	1.2300	.1175	5.25	1.05	.1925	.75	27,500
April, .	60,000	47	48	1h. 42m.	Slight.	.30	0.1995	.0573	8.08	2.94	.0200	.54	11,800
May, . .	60,000	57	58	19m.	Slight.	.19	0.0097	.0367	7.45	3.70	.0000	.29	6,200
June, . .	60,000	62	63	27m.	V. slight.	.16	0.0085	.0314	8.28	3.79	.0000	.23	3,300
July, . .	53,300	72	74	11m.	V. slight.	.16	0.0018	.0267	10.80	4.05	.0000	.21	1,600
August, .	57,700	71	74	20m.	None.	.15	0.0029	.0272	9.57	3.52	.0000	.22	1,200
September,	57,700	67	72	12m.	None.	.13	0.0121	.0265	12.64	4.62	.0002	.24	900
October, .	60,000	57	61	12m.	V. slight.	.14	0.0596	.0231	11.72	4.06	.0001	.25	1,100
November,	60,000	46	48	42m.	Slight.	.15	0.2252	.0420	6.56	2.78	.0017	.29	10,900
December, .	77,000	47	40	4h. 45m.	Slight.	.21	0.3900	.0566	4.86	1.18	.0307	.39	6,500
Average,	60,500	56	55	1h. 53m.	-	.27	0.4086	.0581	8.09	2.82	.0385	.41	11,700

Sewage applied, 300 gallons six times a week from January 1 to December 5; 500 gallons six times a week from December 6 to 31. July 15 to 18, experiment interrupted by freshet. During January, $22\frac{1}{2}$ inches of snow and $5\frac{3}{4}$ inches of ice removed from surface; during February, 12 inches of snow and $1\frac{1}{4}$ inches of ice removed; during March, $3\frac{1}{2}$ inches of snow removed; during November, $2\frac{1}{2}$ inches of snow removed; during December, $7\frac{1}{2}$ inches of snow and $4\frac{1}{2}$ inches of ice removed.

Filter No. 9 A.

This filter contains 5 feet in depth of sand of an effective size of 0.17 millimeter. It has been in good condition throughout the year, has taken the applied sewage readily and given an effluent of a satisfactory quality. The average rate of filtration has been 61,500 gallons per acre daily. The surface of the filter has been raked 1 inch deep each week, and dug over to a depth of from 6 to 8 inches on April 26, September 6 and November 17. The following table gives the monthly averages of the analyses of the effluent of this filter: —

Effluent of Filter No. 9A.

[Parts per 100,000.]

1897.	Quantity Applied. Gallons per Acre Daily for Six Days in a Week.	Temperature. Deg. F. Sewage.	Temperature. Deg. F. Effluent.	Length of Time Sewage Remained on Surface. Hours and Minutes.	Appearance. Turbidity.	Appearance. Color.	Ammonia. Free.	Ammonia. Albuminoid.	Chlorine.	Nitrogen as Nitrates.	Nitrogen as Nitrites.	Oxygen Consumed.	Bacteria per Cubic Centimeter.
January,	57,700	47	39	20h. 28m.	Decided.	.67	2.5933	.1733	9.34	1.60	.0177	1.14	27,500
February,	56,700	45	38	11h. 51m.	Decided.	.49	1.8500	.0980	7.48	1.60	.0185	0.70	26,500
March,	60,000	45	40	2h. 18m	V. slight.	.38	1.0900	.0790	6.62	2.79	.0193	0.65	10,500
April,	60,000	47	49	1h. 30m.	Decided.	.40	0.5110	.0787	7.78	3.89	.0215	0.61	24,300
May,	60,000	58	57	21m.	V. slight.	.19	0.0239	.0382	9.51	5.05	.0001	0.33	11,100
June,	60,000	63	62	11m.	V. slight.	.18	0.0085	.0257	11.58	4.45	.0000	0.24	1,100
July,	55,500	72	73	9m.	Slight.	.16	0.0113	.0276	9.27	4.49	.0000	0.25	341
August,	60,000	71	73	23m.	None.	.15	0.0051	.0226	11.17	4.54	.0000	0.25	38
September,	57,700	67	70	25m.	None.	.15	0.0326	.0209	13.55	4.78	.0001	0.25	27
October,	60,000	57	61	15m.	None.	.14	0.1235	.0225	11.59	4.15	.0000	0.27	40
November,	60,000	47	50	1h. 48m.	V. slight.	.29	0.9100	.0520	8.98	2.40	.0005	0.47	26,800
December,	90,400	45	41	3h. 14m.	Decided.	.41	0.7580	.0868	4.16	1.29	.0010	0.57	9,260
Average,	61,500	55	54	3h. 34m.	–	.30	0.6598	.0604	9.25	3.42	.0066	0.48	11,460

Sewage applied, 300 gallons six times a week from January 1 to December 5; 500 gallons six times a week from December 6 to 31. July 15 to 18, experiment interrupted by freshet. During January, 23¼ inches of snow and 7⅜ inches of ice removed; during February, 16 inches of snow and 2½ inches of ice removed; during March, 3 inches of snow removed; during November, 2½ inches of snow removed; during December, 7½ inches of snow and 3 inches of ice removed.

Filter No. 10.

Filter No. 10 is $\frac{1}{200}$ of an acre in area, and contains 5 feet in depth of mixed coarse and fine sand of an effective size of 0.35 millimeter. No underdrains are beneath the sand, except directly above and around the outlet pipe. A partition, extending 3 feet below the surface, separates the quarter of the surface farthest from the underdrains from the remainder of the surface. To this quarter of the surface the sewage has been applied during 1897 at a rate of 120,000 gallons per acre daily. The filter has been in good condition throughout the year, has disposed of the applied sewage readily and has given a satisfactory effluent, as shown by the table below. The portion of the surface to which sewage is applied has been raked over 1 inch deep each week, and dug over to a depth of from 6 to 8 inches on April 16 and September 6. Upon November 17 the entire surface was dug over to a depth of 6 inches.

Effluent of Filter No. 10.

[Parts per 100,000.]

1897.	Quantity Applied. — Gallons per Acre Daily for Six Days in a Week.	Temperature. Deg. F.		Length of Time Sewage Remained on Surface. — Hours and Minutes.	Appearance.		Ammonia.		Chlorine.	Nitrogen as		Oxygen Consumed.	Bacteria per Cubic Centimeter.
		Sewage.	Effluent.		Turbidity.	Color.	Free.	Albuminoid.		Nitrates.	Nitrites.		
January,	27,700	46	41	12h. 53m.	Decided.	.39	1.4400	.1170	6.65	1.29	.0883	.62	12,800
February,	30,000	45	38	4h. 4m.	Slight.	.39	1.0800	.0715	5.45	1.08	.0875	.57	11,500
March,	30,000	46	41	3h. 40m.	V. slight.	.25	0.7425	.0750	6.00	1.74	.0850	.48	5,500
April,	30,000	47	48	2h. 27m.	V. slight	.20	0.1752	.0504	6.40	3.49	.0167	.34	1,400
May,	30,000	58	56	15m.	V. slight.	.18	0.0356	.0351	6.13	4.08	.0001	.27	1,600
June,	30,000	62	63	10m.	V. slight	.16	0.0218	.0279	6.96	4.05	.0000	.23	1,400
July,	25,500	73	71	11m.	V. slight.	.16	0.0176	.0334	8.87	4.39	.0000	.28	3,243
August,	30,000	72	73	25m.	None.	.15	0.0044	.0255	9.88	3.61	.0000	.24	175
September,	28,900	67	70	22m.	None.	.15	0.0336	.0224	12.47	4.73	.0001	.21	122
October,	30,000	58	62	15m.	None.	.14	0.1632	.0301	10.53	3.92	.0009	.27	235
November,	30,000	47	51	45m.	Slight.	.15	0.2900	.0380	7.51	2.48	.0135	.32	584
December,	30,000	44	43	51m.	Decided.	.38	1.3350	.1370	8.92	1.46	.0178	.87	13,660
Average,	29,500	55	55	2h. 12m.	–	.23	0.4449	.0553	7.98	3.03	.0258	.39	4,350

Sewage applied, 150 gallons six times a week. July 15 to 19, experiment interrupted by freshet. During December, 20 inches of snow and 4⅝ inches of ice removed from that part of surface to which sewage is applied; during February, 10 inches of snow and ½ inch of ice removed; during March, 3 inches of snow removed; during November, 2½ inches of snow removed; during December, 7 inches of snow and 4⅞ inches of ice removed.

Filters Nos. 12 A, 15 B and 16 B.

These three filters were constructed in July, 1892, and a summary of the methods of operation and results up to Jan. 1, 1896, was given in the report for 1895. Filter No. 12 A contains approximately 60 inches in depth of sand of an effective size of 0.19 millimeter, and filters Nos. 15 B and 16 B contain 65 inches in depth of gravel stones of an effective size of 5 4 millimeters. Up to Sept. 1, 1897, Filter No. 12 A received as large a volume of the effluents of filters Nos. 15 B and 16 B as it was capable of caring for, and the rate of filtration is shown by the table beyond. On that date filters Nos. 15 B and 16 B were discontinued, and for the rest of the year Filter No. 12 A had applied to it the effluent of Filter No. 82, at a rate of 720,000 gallons per acre daily, with the results shown in the table beyond. The surface of Filter No. 12 A was raked 3 inches

deep twice each week during the year, and dug over 6 inches deep on June 15 and November 15.

Filters Nos. 15 B and 16 B were operated during the first nine months of the year at a rate less by 120,000 gallons per acre daily than during previous years ; but notwithstanding this lowering of the rate, the filters became badly clogged in August, and, in order to continue them in operation, the material would have had to be removed and washed, as had been done several times in previous years. As it was, the underdrains of the filters had to be flushed out with city water under pressure several times during the period of operation in 1897 in order to remove clogging. Filter No. 15 B had a current of air drawn through it, as in previous years, for eight hours during each night. Filter No. 16 B was aspirated eight hours each night from January 1 to May 26, fifteen hours each night from May 27 to June 2, continuously from June 9 to 19, while the filter was out of operation, and eight hours each night from July 20 to August 31.

Effluent of Filter No. 12 A.

[Parts per 100,000.]

1897.	Quantity Applied. Gallons per Acre Daily for Six Days in a Week.	Temperature. Deg. F.		Length of Time Sewage Remained on Surface. Hours and Minutes.	Appearance.		Ammonia.		Chlorine.	Nitrogen as		Oxygen Consumed.	Bacteria per Cubic Centimeter.
		Sewage.	Effluent.		Turbidity.	Color.	Free.	Albuminoid.		Nitrates.	Nitrites.		
January, .	200,000	44	47	-	None.	.11	.0026	.0172	6.60	2.89	.0000	.16	213
February, .	488,000	45	48	43m.	None.	.15	.0079	.0213	7.24	2.51	.0000	.16	542
March, .	621,000	46	48	42m.	None.	.14	.0105	.0244	7.00	2.75	.0000	.19	757
April, . .	584,000	53	52	39m.	None.	.17	.0748	.0256	7.37	3.04	.0000	.23	765
May, . .	584,000	55	59	46m.	None.	.17	.1174	.0407	7.88	3.15	.0000	.27	824
June, . .	329,000	57	63	26m.	V. slight.	.18	.0303	.0284	8.45	2.84	.0000	.25	427
July, . .	386,000	68	66	20m.	V. slight.	.22	.0171	.0432	9.31	2.31	.0001	.35	2,228
August, .	632,000	69	68	49m.	Slight.	.26	.0240	.0386	14.76	2.40	.0001	.38	6,420
September,	720,000	66	62	55m.	V. slight.	.12	.0254	.0217	8.52	2.84	.0001	.22	3,280
October, .	720,000	58	59	1h. 20m.	Slight.	.27	.0686	.0329	12.97	3.06	.0003	.31	3,232
November, .	651,000	48	52	1h. 35m.	V. slight.	.24	.0618	.0329	9.62	2.73	.0000	.39	697
December, .	720,000	47	47	1h. 53m.	V. slight.	.31	.4200	.0520	8.74	2.80	.0004	.49	954
Average,	553,000	55	56	55m.	-	.20	.0717	.0316	9.04	2.78	.0001	.28	1,695

Five gallons of effluent of Filter No. 15 applied twelve times a week, January 1 to February 7; all the effluent of Nos. 15 and 16 twenty-four times a week, February 8 to May 26; effluent of No. 15 twenty-four times a week, May 27 to July 19; all the effluent of Nos. 15 and 16 twenty-four times a week, July 20 to August 31; 9 gallons of effluent of No 82 twenty-four times a week, September 1 to December 31. July 15 to 18, experiment interrupted by freshet. November 11 to 15, filter allowed to rest.

Effluent of Filter No. 15 B.

[Parts per 100,000.]

1897.	Quantity Applied. Gallons per Acre Daily for Six Days in a Week.	Temperature. Deg. F. Sewage.	Effluent.	Length of Time Sewage Remained on Surface. Hours and Minutes.	Appearance. Turbidity.	Color.	Ammonia. Free.	Albuminoid.	Chlorine.	Nitrogen as Nitrates.	Nitrites.	Oxygen Consumed.	Bacteria per Cubic Centimeter.
January,	360,000	48	45	0	Decided.	.36	0.1210	.0795	8.93	2.73	.0078	0.52	89,300
February,	360,000	48	47	0	Decided.	.31	0.1000	.0720	6.79	2.28	.0093	0.40	78,000
March,	360,000	50	47	0	Decided.	.27	0.1407	.0767	7.34	1.97	.0093	0.44	109,200
April,	360,000	57	55	0	Slight.	.28	0.1093	.0707	7.48	2.12	.0040	0.43	56,100
May,	360,000	64	58	0	Decided.	.35	0.2400	.1168	7.29	2.51	.0077	0.52	54,800
June,	360,000	66	63	0	Decided.	.78	1.3800	.1427	6.71	0.62	.0040	0.88	261,300
July,	320,000	76	71	0	Great.	.90	1.5933	.1840	10.10	0.50	.0042	1.00	432,000
August,	360,000	72	69	0	Great.	.73	1.7533	.1653	11.73	0.66	.0097	0.95	531,700
Average,	355,000	60	57	–	–	.50	0.6797	.1135	8.30	1.67	.0070	0.64	210,600

Sewage applied, $1\frac{1}{2}$ gallons seventy-two times a week, January 1 to August 31. July 15 to 18, experiment interrupted by freshet Surface raked 3 inches deep once each week. Underdrains washed out with city pressure, May 12 and August 20.

Effluent of Filter No. 16 B.

[Parts per 100,000.]

1897.	Quantity Applied. Gallons per Acre Daily for Six Days in a Week.	Temperature. Deg. F. Sewage.	Effluent.	Length of Time Sewage Remained on Surface. Hours and Minutes.	Appearance. Turbidity.	Color.	Ammonia. Free.	Albuminoid.	Chlorine.	Nitrogen as Nitrates.	Nitrites.	Oxygen Consumed.	Bacteria per Cubic Centimeter.
January,	360,000	48	42	0	Decided.	0.45	0.5125	.1220	7.39	2.50	.0045	0.77	123,300
February,	360,000	48	43	0	Decided.	0.31	0.4225	.0955	7.03	2.45	.0067	0.53	88,300
March,	360,000	50	45	0	Slight.	0.26	0.4333	.0940	7.53	2.52	.0068	0.55	21,300
April,	360,000	57	50	0	Decided.	0.41	0.9133	.2473	7.08	2.52	.0077	1.26	92,000
May,	311,000	64	52	0	Great.	1.63	2.0920	.4925	7.25	1.15	.0115	2.43	259,400
June,	–	66	50	0	Great.	1.00	2.0000	.8700	2.29	1.05	.0220	3.30	33,000
July,	147,000	76	65	0	Great.	0.46	1.2400	.0900	12.32	1.84	.0080	0.64	336,000
August,	360,000	72	68	0	Great.	0.48	1.1200	.1240	12.29	1.70	.0220	0.73	273,800
Average,	323,000	60	52	–	–	0.63	1.0917	.2669	7.90	1.97	.0112	1.28	153,400

Sewage applied, $1\frac{1}{2}$ gallons seventy-two times a week, January 1 to May 26; 1 gallon of city water twelve times a week, May 27 to June 2; $1\frac{1}{2}$ gallons of sewage seventy-two times a week, July 20 to August 31. June 3 to July 19, filter allowed to rest. July 15 to 17, experiment interrupted by freshet. Surface raked 3 inches deep once each week, except during period of rest. Underdrains washed out with city pressure on the following dates: February 19, April 27, May 12 and May 20.

Filter No. 13 A.

This filter contains 60 inches in depth of medium fine sand of an effective size of 0.19 millimeter, and has received sewage from which a certain amount of the organic matter has been removed by allowing the sewage to stand for four hours for sedimentation to take place. The rate of filtration for the year has averaged 152,000 gallons per acre daily. Operating at this rate, good results have been obtained, the effluent has been clear, low in color and without turbidity during the greater part of the year. The surface of the filter has been raked 3 inches deep twice each week, and dug over to a depth of 6 inches April 23 and October 1. The filter was continued in operation during the first two months of 1898, but on March 1, 1898, the filter was discontinued, after being in operation and receiving settled sewage since January, 1892, and having filtered a volume of sewage equal to 241,400,000 gallons upon an acre.

Effluent of Filter No. 13 A.

[Parts per 100,000.]

1897.	Quantity Applied. — Gallons per Acre Daily for Six Days in a Week.	Temperature. Deg. F.		Length of Time Sewage Remained on Surface. — Hours and Minutes.	Appearance.		Ammonia.		Chlorine.	Nitrogen as		Oxygen Consumed.	Bacteria per Cubic Centimeter.
		Sewage.	Effluent.		Turbidity.	Color.	Free.	Albuminoid.		Nitrates.	Nitrites.		
January, .	160,000	48	47	15m.	V. slight.	.16	.0997	.0302	6.90	2.86	.0000	.25	256
February, .	160,000	48	49	15m.	None.	.16	.0900	.0266	6.95	3.12	.0000	.21	119
March, .	160,000	50	48	16m.	None.	.15	.1165	.0274	7.65	3.03	.0000	.23	137
April, . .	117,000	57	52	14m.	None.	.20	.1180	.0304	6.29	3.46	.0000	.28	101
May, . .	160,000	64	60	10m.	None.	.20	.4700	.0430	8.47	4.33	.0000	.30	167
June, . .	160,000	66	63	15m.	None.	.16	.0582	.0450	7.18	5.61	.0000	.23	75
July, . .	142,000	76	70	14m.	None.	.13	.0066	.0285	6.93	3.28	.0001	.22	87
August, .	160,000	72	69	15m.	None.	.13	.0077	.0244	7.38	3.30	.0001	.24	92
September,	160,000	67	62	16m.	None.	.11	.0561	.0218	8.15	3.30	.0001	.26	75
October, .	123,000	62	63	16m.	V. slight.	.17	.3800	.0290	11.95	3.92	.0000	.27	272
November, .	160,000	52	49	15m.	None.	.16	.2770	.0310	8.16	3.04	.0000	.35	114
December, .	160,000	47	47	17m.	None.	.11	.0435	.0164	4.26	1.80	.0000	.21	131
Average,	152,000	59	57	15m.	-	.15	.1436	.0295	7.52	3.42	.0000	.25	136

Settled sewage applied, 4 gallons twelve times a week. April 23 to 30 and October 1 to 7, filter allowed to rest. July 15 to 18, experiment interrupted by freshet.

Filter No. 14 A.

This filter contains 60 inches in depth of medium fine sand of an effective size of 0.19 millimeter, and has received, since June 1, 1894, sewage which has first been strained through a shallow layer of coke breeze at a rate of 1,000,000 gallons per acre daily. This partially purified sewage has been applied to the filter during 1897 at an average rate of 280,000 gallons per acre daily, and the effluent of the filter has been of a very satisfactory quality, being clear, with slight turbidity and low color. The surface of the filter has been raked 3 inches deep twice each week, and dug over 6 inches deep upon April 9 and October 1. On January 23 the upper 6 inches of sand were removed, washed and replaced in the filter.

Effluent of Filter No. 14 A.

[Parts per 100,000.]

1897.	Quantity Applied. — Gallons per Acre Daily for Six Days in a Week.	Temperature. Deg. F.		Length of Time Sewage Remained on Surface. — Hours and Minutes.	Appearance.		Ammonia.		Chlorine.	Nitrogen as		Oxygen Consumed.	Bacteria per Cubic Centimeter.
		Sewage.	Effluent.		Turbidity.	Color.	Free.	Albuminoid.		Nitrates.	Nitrites.		
January, .	103,000	48	45	1h. 2m.	None.	.26	.6934	.0459	9.57	1.92	.0019	.34	6,100
February, .	280,000	48	48	30m.	V. slight.	.16	.0126	.0201	7.72	2.68	.0000	.17	548
March, .	320,000	50	46	1h. 24m.	V. slight.	.22	.8300	.0513	7.42	1.88	.0034	.33	2,000
April, . .	209,000	57	51	1h. 8m.	None.	.62	.8800	.0436	8.20	3.03	.0024	.42	6,900
May, . .	320,000	64	59	11m.	None.	.15	.0555	.0231	12.05	3.81	.0003	.18	197
June, . .	317,000	66	62	15m.	None.	.15	.0379	.0243	14.07	3.67	.0000	.21	283
July, . .	284,000	76	69	17m.	None.	.11	.0164	.0208	6.30	2.53	.0001	.19	454
August, .	320,000	72	68	23m.	None.	.13	.0792	.0275	12.57	2.76	.0001	.24	222
September,	320,000	67	61	18m.	None.	.11	.0913	.0234	9.09	2.90	.0001	.24	397
October, .	246,000	62	61	18m.	V. slight.	.19	.6550	.0390	12.99	4.07	.0008	.33	121
November, .	320,000	52	49	20m.	None.	.17	.5050	.0400	9.01	3.83	.0020	.39	85
December, .	317,000	47	47	25m.	None.	.12	.0588	.0210	4.18	1.87	.0001	.22	29
Average,	279,700	59	56	33m.	-	.20	.3263	.0317	9.43	2.91	.0009	.27	1,445

Four gallons of sewage strained through coke applied twenty-four times a week, January 1 to 21; 2 gallons of sewage twenty-four times a week, January 22 to February 7; 4 gallons of sewage twenty-four times a week, February 8 to December 31. No sewage applied April 8 to 18 and October 1 to 7. July 15 to 18, experiment interrupted by freshet.

Filter No. 19.

This filter contains 60 inches in depth of medium fine sand of an effective size of 0.19 millimeter, and has received the supernatant sewage resulting from treating the regular sewage with sulphate of alumina in the proportion of 1,000 pounds per 1,000,000 gallons, and then allowing the sewage to stand four hours for sedimentation to take place. The filter was first put in operation, receiving this chemically treated sewage, upon Jan. 20, 1893, and continued until March 1, 1898. During this period it filtered a volume of sewage equal to 328,980,000 gallons upon an acre. During 1897 and the first two months of 1898 the rate of filtration maintained by this filter averaged 190,000 gallons per acre daily. Operating at this rate, a very satisfactory effluent has been obtained, as shown by the table below. The surface of the filter has been raked 3 inches deep twice each week, and dug over to a depth of 6 inches April 23 and October 1.

Effluent of Filter No. 19.

[Parts per 100,000.]

1897.	Quantity Applied. — Gallons per Acre Daily for Six Days in a Week.	Temperature. Deg. F.		Length of Time Sewage Remained on Surface. — Minutes.	Appearance.		Ammonia.		Chlorine.	Nitrogen as		Oxygen Consumed.	Bacteria per Cubic Centimeter.
		Sewage.	Effluent.		Turbidity.	Color.	Free.	Albuminoid.		Nitrates.	Nitrites.		
January, .	200,000	48	43	26m.	None.	.14	.3550	.0385	6.20	2.36	.0118	.24	522
February, .	200,000	48	44	46m.	None.	.16	.6150	.0300	6.17	2.29	.0375	.24	427
March, .	200,000	50	43	36m.	None.	.13	.6233	.0327	6.16	2.04	.0407	.26	408
April, . .	146,000	57	49	25m.	None.	.18	.4850	.0310	6.23	2.63	.0280	.28	177
May, . .	200,000	64	58	14m.	None.	.17	.5933	.0480	6.98	3.34	.0093	.29	7,600
June, . .	200,000	66	62	18m.	V. slight.	.17	.1293	.0257	7.30	3.32	.0005	.24	27
July, . .	178,000	76	71	13m.	V. slight.	.13	.0106	.0233	6.11	2.91	.0000	.23	128
August, .	200,000	72	68	15m.	None.	.13	.0070	.0234	6.70	2.95	.0000	.24	38
September,	200,000	67	62	20m.	None.	.11	.0561	.0207	8.51	3.10	.0000	.22	51
October, .	154,000	62	54	21m.	None.	.16	.6400	.0350	12.75	3.52	.0007	.24	84
November, .	200,000	52	46	25m.	None.	.11	.5450	.0460	8.61	3.06	.0002	.29	14
December, .	200,000	47	44	47m.	None.	.09	.1659	.0195	4.24	1.52	.0000	.17	109
Average,	190,000	59	54	26m.	-	.14	.3521	.0312	7.16	2.75	.0107	.25	800

Five gallons of sewage applied twelve times a week, except from April 23 to 30 and October 1 to 7, when filter was allowed to rest. July 15 to 18, experiment interrupted by freshet.

Filter No. 21 A.

This filter contains 60 inches in depth of fine sifted gravel of an effective size of 1.6 millimeters. It was first put in operation March 19, 1894, according to the method of the so-called bacterial filters, but since July 7 of the same year, while flooded in the same way, has also had a current of air drawn through it each day for a period varying from ten to sixteen hours. Very interesting and satisfactory results, from a scientific point of view, have always been obtained from this filter, but the filtering material has needed considerable attention from time to time, as, notwithstanding the air introduced into the filter by the method of flooding, and the air drawn through it by the aspirator, the filter has clogged badly from time to time, and has either had to remain out of operation with continuous aeration for a considerable period, or else the gravel removed and the stored organic matter washed from it. During January of 1897 nitrification practically ceased in the filter, and from January 23 to February 7 city water was applied in small doses, instead of sewage, aeration being continued. Nitrification started, and considerable of the organic matter stored in the filter was removed by this treatment, and sewage was again applied. Nitrification again being practically inactive, city water was applied in various volumes during April, May and June, with various amounts of aeration. By this procedure considerable organic matter was removed from the filtering material, but much remained, as shown by analyses of this material.

During this period, also, many determinations were made of oxygen and carbonic acid gas in the air taken from the interior of this filter, to show the effect of much or little aeration, and also to show how quickly the air drawn into the filter became exhausted of its oxygen when allowed to remain in the filter. (See page 430.)

Effluent of Filter No. 21 A.

[Parts per 100,000.]

1897.	Quantity Applied.	Temperature. Deg. F.		Average Number of Applications which remained on Surface less than 30 Minutes.	Appearance.		Ammonia.		Chlorine.	Nitrogen as		Oxygen Consumed.	Bacteria per Cubic Centimeter.
	Gallons per Acre Daily for Six Days in a Week.	Sewage.	Effluent.		Turbidity.	Color.	Free.	Albuminoid.		Nitrates.	Nitrites.		
January,	201,000	48	42	3	Decided.	.44	.2101	.0971	7.88	2.59	.0005	.57	46,700
February,	280,000	48	43	9	Decided.	.34	.3500	.1013	6.86	1.73	.0021	.62	154,300
March,	307,000	50	43	4	Decided.	.34	.2330	.0830	7.14	1.63	.0016	.62	109,500
May,	-	-	-	-	-	-	-	-	-	13.24	-	-	-
June,	82,000	66	65	-	Decided.	.31	.0187	.0720	0.19	11.61	.0077	.39	12,500
Average,	217,500	53	48	5	-	.36	.2030	.0884	5.52	-	.0030	.55	80,800

Sewage applied, $1\frac{1}{2}$ gallons seventy-two times a week, January 1 to 12; $1\frac{1}{2}$ gallons six times a week, January 13 to 18; $1\frac{1}{2}$ gallons seventy-two times a week, January 19 to 22; 1 gallon of city water twelve times a week, January 23 to February 7; $1\frac{1}{2}$ gallons of sewage seventy-two times a week, February 8 to March 26; March 27 to May 26, filter allowed to rest; 1 gallon of city water twelve times a week, May 27 to June 7; 1 gallon of city water twenty-four times a week, June 8 to 16; June 17 and 19, 2 gallons of city water applied at intervals of one-half hour, until surface was covered, and filter allowed to stand for twenty-four hours; 1 gallon of city water twenty-four times a week, June 22 to 30. Filter was aspirated sixteen hours each night, January 1 to 12; continuously, January 13 to 18; sixteen hours each night, January 19 to 22; continuously, January 23 to February 7; sixteen hours each night, February 8 to March 26; continuously, March 27 to June 7; fifteen hours each night, June 8 to 30, except when surface was covered (June 17 and 19). Surface dug over to a depth of 6 inches on the following dates: January 19, March 30, April 3, 6, 8, 10, 13, 15, 17, 20, 22, 24, 27, 29, May 1, 4, 6, 8, 11, 13, 15, 18, 20, 22, 25 and 27.

Filter No. 65.

This filter contains, over the usual gravel underdrains, 60 inches in depth of coke breeze, and was first put in operation Jan. 4, 1896. The sewage applied is of the same strength as that applied to the sand Filter No. 14 A, and has first been strained through a shallow layer of coke breeze. The rate of filtration maintained during the year has averaged 311,000 gallons per acre daily, and a very satisfactory effluent has been obtained. The surface of the filter has been raked 3 inches deep twice each week, and dug over to a depth of 6 inches on May 21, October 1 and December 18.

Effluent of Filter No. 65.

[Parts per 100,000.]

1897.	Quantity Applied. — Gallons per Acre Daily for Six Days in a Week.	Temperature. Deg. F.		Length of Time Sewage Remained on Surface. — Minutes.	Appearance.		Ammonia.		Chlorine.	Nitrogen as		Oxygen Consumed.	Bacteria per Cubic Centimeter.
		Sewage.	Effluent.		Turbidity.	Color.	Free.	Albuminoid.		Nitrates.	Nitrites.		
January, .	300,000	48	45	9m.	Slight.	.20	.3775	.0480	9.84	2.73	.0052	.30	12,300
February, .	300,000	48	46	11m.	Slight.	.19	.2015	.0371	6.58	2.57	.0029	.19	7,500
March, .	300,000	50	48	14m.	Slight.	.16	.1960	.0380	6.78	2.52	.0043	.22	6,100
April, . .	300,000	57	52	12m.	Slight.	.20	.2167	.0360	7.81	3.16	.0048	.23	9,600
May, . .	300,000	64	59	7m.	Decided.	.23	.3920	.0640	11.24	3.73	.0057	.33	18,000
June, . .	300,000	66	63	10m.	Decided	.18	.2385	.0476	12.60	3.23	.0039	.21	10,500
July, . .	267,000	76	71	12m.	Slight.	.10	.0488	.0256	9.47	2.56	.0015	.16	67,200
August, .	300,000	72	70	16m.	V. slight.	.11	.0446	.0228	7.91	1.89	.0002	.18	21,000
September,	300,000	67	62	32m.	Decided.	.18	.1500	.0410	9.89	2.41	.0010	.23	20,900
October, .	231,000	62	61	17m.	Slight.	.15	.2950	.0320	12.51	3.11	.0015	.22	27,150
November, .	383,000	52	51	27m.	Decided.	.36	.7900	.1150	9.50	3.26	.0015	.61	44,100
December, .	450,400	47	48	52m.	Slight.	.20	.0646	.0310	5.01	1.70	.0004	.29	10,600
Average,	311,000	59	56	18m.	-	.19	.2513	.0449	9.10	2.74	.0027	.26	21,200

Five gallons of sewage strained through coke applied eighteen times a week, January 1 to November 16; 8 gallons eighteen times a week, November 17 to December 31. July 15 to 18, experiment interrupted by freshet. October 1 to 7, filter allowed to rest.

Filters Nos. 66 and 67.

These filters were first put in operation in March, 1896, and their construction and operation for that year were fully described in the last report of the Board. Filter No. 66 was a gravel filter, aerated by forcing air through it from below, and Filter No. 67 was a sand filter, one-half the area of Filter No. 66, and placed directly below it and received the effluent of Filter No. 66. These filters were continued in operation during the first four months of 1897, and the results obtained are shown by the tables following. These results are very interesting, and show how great a purification can be obtained with filters of this character operated as these have been; but the results have not been such as to warrant the belief that their operation upon a large scale would be practicable, owing to the expense of giving the coarse filter a sufficient amount of aeration to enable it to do good work. Of course, with a larger plant the

cost would be less, proportionately, than with the small plant operated at the station; but, as stated in the last report, it seems improbable that it would be reduced sufficiently to be considered reasonable in sewage purification.

Effluent of Filter No. 66.

[Parts per 100,000.]

1897.	Quantity Applied. — Gallons per Acre Daily for Six Days in a Week.	Temperature. Deg. F. Sewage.	Temperature. Deg. F. Effluent.	Length of Time Sewage Remained on Surface. — Minutes.	Appearance. Turbidity.	Appearance. Color.	Ammonia. Free.	Ammonia. Albuminoid. Total.	Ammonia. Albuminoid. In Solution.	Ammonia. Albuminoid. In Suspension.	Chlorine.	Nitrogen as Nitrates.	Nitrogen as Nitrites.	Oxygen Consumed.	Bacteria per Cubic Centimeter.
Jan.,	600,000	50	50	7m.	Decided.	.58	0.9700	.1810	.1430	.0380	5.80	1.45	.0046	1.14	214,000
Feb.,	600,000	50	54	6m.	Decided.	.57	1.2750	.1930	.1425	.0505	6.70	1.17	.0100	1.16	211,500
Mar.,	580,000	47	56	8m.	Decided.	.58	0.9600	.3027	.1453	.1574	6.30	1.26	.0100	1.50	262,300
Apr.,	849,000	47	53	50m.	Decided.	.58	2.0860	.6540	.2104	.4436	10.59	0.76	.0224	3.10	629,600
Av.,	657,000	49	53	18m.	–	.58	1.3228	.3327	.1603	.1724	7.35	1.16	.0118	1.73	329,400

Sewage applied, 20 gallons sixty times a week, January 1 to April 2; 30 gallons sixty times a week, April 3 to 30. Filter aerated 15 minutes sixty times a week. Surface raked 1 inch daily.

Effluent of Filter No. 67.

[Parts per 100,000.]

1897.	Quantity Applied. — Gallons per Acre Daily for Six Days in a Week.	Temperature. Deg. F. Sewage.	Temperature. Deg. F. Effluent.	Length of Time Sewage Remained on Surface. — Hours and Minutes.	Appearance. Turbidity.	Appearance. Color.	Ammonia. Free.	Ammonia. Albuminoid.	Chlorine.	Nitrogen as Nitrates.	Nitrogen as Nitrites.	Oxygen Consumed.	Bacteria per Cubic Centimeter.
January, .	1,177,000	50	50	54m.	V. slight.	.36	.0682	.0490	6.66	1.71	.0178	.50	7,000
February, .	1,163,000	54	53	2h. 13m.	Slight.	.39	.0832	.0528	7.85	1.49	.0078	.47	6,900
March, .	428,000	56	54	1h. 10m.	Slight.	.32	.0838	.0379	7.90	2.09	.0104	.41	7,700
April, . .	213,000	53	54	2h. 23m.	V. slight.	.20	.0688	.0316	7.42	2.64	.0010	.27	3,800
Average,	745,000	53	53	1h. 40m.	–	.32	.0760	.0428	7.46	1.98	.0093	.41	6,400

Effluent of Filter No. 66 applied: January 1 to March 11, four doses of 50 gallons each daily; March 15 to April 16, one dose of 25 gallons daily; April 17 to 30, two doses of 25 gallons each daily; March 12 to 14, filter allowed to rest. Surface raked 3 inches deep daily. Surface dug over to a depth of 6 inches on the following dates: January 29, February 19, 27, March 2, 4, 6, 8, 10, 11, 15.

Filter No. 80.

Filter No. 80 contains 4.5 feet in depth of coal ashes, and has received sewage during 1897 at an average rate of 96,700 gallons per acre daily. The filter was first put in operation in November, 1896.

Nitrification began to become active during January, 1897, and has been good throughout the remainder of the year, and the effluent of the filter has been of a very satisfactory quality, as shown by the following table. The surface of this filter has been raked 3 inches deep once each week during the year, and was dug over to a depth of 6 inches upon December 15.

Effluent of Filter No. 80.

[Parts per 100,000.]

1897.	Quantity Applied. Gallons per Acre Daily for Six Days in a Week.	Temperature. Deg. F.		Length of Time Sewage Remained on Surface. Hours and Minutes.	Appearance.		Ammonia.		Chlorine.	Nitrogen as		Oxygen Consumed.	Bacteria per Cubic Centimeter.
		Sewage.	Effluent.		Turbidity.	Color.	Free.	Albuminoid.		Nitrates.	Nitrites.		
January, .	111,000	47	48	-	V. slight.	.27	2.7600	.1105	9.40	0.95	.0393	.46	11,900
February, .	111,000	45	48	-	None.	.21	1.0450	.0435	9.78	2.24	.0575	.37	6,700
March, .	111,000	45	50	-	V. slight.	.22	1.0433	.0553	10.86	2.50	.0507	.44	7,600
April, . .	111,000	47	57	-	V. slight.	.29	0.5764	.0566	10.32	2.81	.0528	.51	5,500
May, . .	87,000	58	65	1h. 12m.	V. slight.	.17	0.1137	.0264	7.28	2.25	.0168	.18	9,400
June, . .	80,000	63	65	1h. 10m.	V. slight.	.06	0.0072	.0038	7.56	1.75	.0036	.04	2,900
July, . .	71,000	72	79	1h. 41m.	Slight.	.09	0.0063	.0051	9.19	1.84	.0003	.37	4,566
August, .	80,000	71	72	1h. 41m.	V. slight.	.04	0.0015	.0023	9.64	2.52	.0001	.01	104
September,	80,000	67	65	3h. 10m.	None.	.03	0.0072	.0017	9.45	2.52	.0003	.04	71
October, .	105,000	57	59	1h. 55m.	V. slight.	.02	0.1909	.0043	9.70	2.89	.0008	.03	210
November, .	120,000	47	48	3h. 32m.	V. slight.	.08	0.2975	.0195	7.83	2.67	.0032	.07	408
December, .	93,300	45	43	12h. -	V. slight.	.03	0.0537	.0078	5.45	1.72	.0019	.03	157
Average,	96,700	55	58	3h. 18m.	-	.13	0.5086	.0281	8.87	2.22	.0189	.21	4,100

Sewage applied, 4 gallons six times a week, May 8 to October 12; 6 gallons six times a week, October 13 to December 31. July 15 to 18, experiment interrupted by freshet. December 15 to 20, filter allowed to rest.

Filter No. 81.

Filter No. 81 contains 4.5 feet in depth of cinders, and received, until November 1, sewage which had first been strained through coke breeze (see page 423). This is one of the so-called bacterial filters, and the method of operating it is as follows: In the morning the outlet is closed, and the sewage is applied in hourly doses until the surface is covered. Then the filter is allowed to remain for from two to three hours full of sewage, after which the outlet is opened and the filter slowly drained. The average rate of operation of this filter for the year has been 882,000 gallons per acre

daily, and an effluent of good appearance, considering the rate of filtration, and with very little odor, has been obtained. The effluent shows considerable turbidity, but no sediment is deposited upon standing for a period of several days.

Effluent of Filter No. 81.

[Parts per 100,000.]

1897.	Quantity Applied. Gallons per Acre Daily for Six Days in a Week.	Temperature. Deg. F. Sewage.	Temperature. Deg. F. Effluent.	Appearance. Turbidity.	Appearance. Color.	Ammonia. Free.	Ammonia. Albuminoid. Total.	Ammonia. Albuminoid. In Solution.	Chlorine.	Nitrogen as Nitrates.	Nitrogen as Nitrites.	Oxygen Consumed.	Bacteria per Cubic Centimeter.
January, . .	944,000	47	48	Decided.	.70	3.28	.2440	-	8.46	0.12	.0010	1.13	791,000
February, .	888,000	45	48	Decided.	.54	2.44	.1600	-	7.13	0.51	.0043	0.85	510,000
March, . .	888,000	45	50	Decided.	.60	2.11	.1593	-	6.16	0.69	.0026	0.95	512,000
April, . .	854,000	47	57	Decided.	.51	2.54	.1497	-	7.92	1.34	.0027	1.21	703,400
May, . .	888,000	58	64	Great.	.47	2.02	.2305	-	10.12	1.62	.0048	1.03	399,400
June, . .	888,000	63	66	Decided.	.38	1.64	.1595	-	11.24	2.18	.0053	0.72	455,500
July, . .	789,000	72	76	Great.	.47	0.64	.1195	.0853	7.50	1.61	.0208	0.62	353,100
August, . .	888,000	71	72	Decided.	.58	0.73	.1190	.0990	9.21	1.80	.0275	0.71	634,000
September, .	888,000	67	67	Great.	.64	1.53	.1900	.1510	15.10	2.23	.0060	1.09	582,300
October, . .	888,000	57	62	Great.	.55	2.06	.2513	.2100	12.05	1.93	.0055	1.17	470,500
November, .	888,000	47	52	Great.	.99	1.61	.2127	.1633	7.34	1.83	.0103	1.27	569,000
December, .	888,000	45	47	Great.	.52	1.25	.2368	.1892	6.05	0.84	.0022	1.67	385,000
Average, .	882,000	55	59	-	.58	1.82	.1860	.1496	9.02	1.39	.0078	1.04	530,000

Filter No. 82.

Filter No. 82 contains 5 feet in depth of cinders, and is also operated as a bacterial filter. The sewage applied to this filter, however, has not received any treatment before its application, and goes to the surface of the filter in the following manner: across the filter and about 10 inches above its surface an iron pipe is placed, with small orifices extending along its lower half. This pipe is parallel to the filter's surface. The sewage is pumped to a tank elevated above this level, to which the delivery pipe is attached, and, when the gate is opened, the pressure of the sewage causes it to rush from the pipe with considerable force in a large number of broken streams, and by means of this scattering, and the spraying caused by the sewage striking the surface of the filter, considerable air is introduced into the sewage, analyses at different times showing an

average of 38 per cent. of dissolved oxygen present. The average rate of filtration maintained during the year has been 543,000 gallons per acre daily, and a very satisfactory effluent, considering the rate, has resulted from this method of operation.

Effluent of Filter No. 82.

[Parts per 100,000.]

1897.	Quantity Applied. — Gallons per Acre Daily for Six Days in a Week.	Temperature. Deg. F. Sewage.	Temperature. Deg. F. Effluent.	Length of Time Sewage Remained on Surface. — Hours and Minutes.	Appearance. Turbidity.	Appearance. Color.	Ammonia. Free.	Ammonia. Albuminoid. Total.	Ammonia. Albuminoid. In Solution.	Chlorine.	Nitrogen as Nitrates.	Nitrogen as Nitrites.	Oxygen Consumed.	Bacteria per Cubic Centimeter.
Apr.,	484,000	47	49	0	Decided.	.47	3.86	.2370	–	9.81	0.05	.0113	1.06	581,000
May,	465,000	57	59	0	Great.	.46	2.26	.2304	–	7.77	0.91	.0436	1.14	412,400
June,	484,000	62	61	0	Decided.	.37	2.27	.2045	.1225	10.70	2.13	.0305	0.93	521,600
July,	405,000	71	74	0	Great.	.46	0.89	.1905	.1075	9.22	1.75	.0065	1.06	299,000
Aug.,	484,000	70	71	0	Great.	.47	1.67	.2320	.1340	11.50	2.29	.0040	1.35	660,000
Sept.,	608,000	65	63	0	Great.	.52	2.04	.3000	.1940	13.59	1.32	.0100	1.48	467,000
Oct.,	724,000	56	58	0	Great.	.51	2.23	.2070	.1720	12.17	0.71	.0036	1.12	622,000
Nov.,	609,000	47	48	0	Great.	.81	1.09	.1973	.1580	6.06	0.93	.0027	1.38	517,000
Dec.,	623,000	50	47	0	Great.	.56	2.00	.2592	.2060	10.01	1.31	.0570	1.34	607,000
Av.,	543,000	58	59	–	–	.51	2.04	.2287	.1563	10.09	1.27	.0188	1.21	520,800

Sewage applied, 11 gallons thirty times a week, April 12 to September 13; 10 gallons forty-eight times a week, September 14 to October 31; 10 gallons forty-two times a week, November 1 to December 31. After September 13 faucet was closed and filter flooded with 10 gallons of sewage hourly until surface was covered. After standing two hours, faucet was opened part way and filter allowed to drain. After November 24 surface allowed to remain covered three hours daily. Surface raked 2 inches deep twice each week. July 15 to 18, experiment interrupted by freshet.

Filters Nos. 83 and 84.

These are two small filters in galvanized iron cylinders, 6 inches in diameter. Filter No. 83 contains 4.5 feet in depth of sand of an effective size of 0.23 millimeter, and Filter No. 84 contains the same depth of coal ashes. These filters were constructed and have been operated for the purpose of finding out whether urine could be purified by the action of nitrification within the filter, without dilution with other liquid. The results obtained show that, during the period when urine alone was applied, little or no nitrification took place within these filters, and that the dilution with sewage and with the liquid produced by soaking hay in canal water had to be considerable before nitrification started. It can be said, also, that the nitrates became very high in the effluent of the sand filter, while with the cinder filter, although the nitrites became high, the nitrates remained

low during the entire period of operation throughout the year, with the exception of the month of November. The cinder filter removed a very large percentage of the color of the applied sewage, while little or no color was removed by the sand filter, its effluent always being brown or red. The method of operating the filter and the different proportions of liquids applied are shown by the notes given below, both filters having been operated in exactly the same way during the year. For discussion see page 431.

Sewage applied to Filters Nos. 83 and 84.

[Parts per 100,000.]

1897.	Ammonia.		Chlorine.	Oxygen Consumed.	Bacteria per Cubic Centimeter.
	Free.	Albuminoid.			
May,	220.0	11.50	212	33.60	1,380,000
June,	219.0	7.43	227	29.30	782,400
July,	213.3	12.03	198	39.13	1,629,000
August,	126.7	5.43	138	26.93	1,099,000
September,	291.5	9.00	358	39.80	570,000
October,	450.0	15.58	603	61.50	186,000
November,	725.0	21.75	917	86.50	3,000
December,	843.3	44.67	1019	105.33	4,700
Average,	386.1	15.92	459	52.76	707,000

Effluent of Filter No. 83.

[Parts per 100,000.]

1897.	Quantity Applied. Gallons per Acre Daily for Six Days in a Week.	Temperature. Deg. F.		Length of Time Sewage Remained on Surface. Hours and Minutes.	Turbidity.	Ammonia.		Chlorine.	Nitrogen as		Oxygen Consumed.	Bacteria per Cubic Centimeter.
		Sewage.	Effluent.			Free.	Albuminoid.		Nitrates.	Nitrites.		
May,	197,000	58	62	37m.	Great.	205.33	7.33	203.00	0.24	0.0000	21.40	17,274,000
June,	111,000	63	66	1h. 13m.	Great.	205.60	3.26	209.20	0.05	0.0000	10.56	16,592,000
July,	95,000	72	76	1h. 33m.	Great.	205.33	4.60	189.50	0.06	0.0000	17.60	6,673,000
August,	64,000	71	72	45m.	Great.	109.33	1.78	117.00	0.08	0.4000	9.93	377,000
September,	25,000	67	68	4m.	Great.	137.00	2.10	256.70	2.94	0.8738	12.45	351,000
October,	16,000	62	57	8m.	Decided.	195.00	2.43	440.00	37.96	32.5500	47.25	260,000
November,	14,000	52	47	36m.	Slight.	281.50	3.45	594.50	18.66	53.0000	62.50	95,000
December,	12,300	47	42	4h. 39m.	Decided.	675.71	12.86	811.67	0.40	0.5527	62.00	167,000
Average,	66,800	61	61	1h. 12m.	-	251.81	4.73	352.72	7.55	10.9221	30.46	5,224,000

Effluent of Filter No. 84.

[Parts per 100,000.]

1897.	Quantity Applied. — Gallons per Acre Daily for Six Days in a Week.	Temperature. Deg. F.		Length of Time Sewage Remained on Surface. — Hours and Minutes.	Appearance.		Ammonia.		Chlorine.	Nitrogen as		Oxygen Consumed.	Bacteria per Cubic Centimeter.
		Sewage.	Effluent.		Turbidity.	Color.	Free.	Albuminoid		Nitrates.	Nitrites.		
May, .	197,000	58	63	1h. 20m.	Great.	.62	175.33	1.97	162.90	0.12	0.0040	3.73	1,330,000
June, .	111,000	63	67	3h. 3m.	Decided.	.67	207.20	1.29	201.20	0.04	0.0004	3.26	2,204,000
July, .	95,000	72	75	2h. 5m.	Great.	*	214.67	2.09	199.70	0.06	0.0000	5.87	7,350,000
August,	64,000	71	70	7h. 2m,	Great.	*	116.67	2.04	130.50	0.77	8.0000	9.43	5,207,000
Sept., .	25,000	67	68	20m.	Decided.	.54	140.00	1.24	199.50	0.01	21.6667	15.05	756,000
Oct., .	16,000	62	57	22m.	V. slight.	.41	213.00	1.05	375.75	0.16	28.5000	34.00	48,000
Nov., .	14,000	52	47	47m.	V. slight.	.98	294.00	1.14	502.50	1.96	31.0000	29.00	60,000
Dec., .	12,300	47	42	2h. 43m.	Slight.	.68	518.57	4.58	613.00	0.05	7.6670	14.00	38,500
Av., .	66,800	62	61	2h. 13m.	-	.65	234.93	1.93	298.13	0.40	12.1048	14.29	2,122,000

* Yellow.

Sewage applied, $\frac{3}{4}$ gallon of regular sewage plus $\frac{1}{4}$ gallon of urine six times a week, May 11 to 26; $\frac{3}{8}$ gallon of regular sewage plus $\frac{1}{8}$ gallon of urine six times a week, May 27 to July 19; $\frac{3}{8}$ gallon of regular sewage plus $\frac{1}{8}$ gallon of urine plus 300 cubic centimeters of hay infusion six times a week, July 20 to August 6; 3-16 gallon of regular sewage plus 1-16 gallon of urine plus $\frac{1}{4}$ gallon of hay infusion three times a week, August 7 to September 3; $\frac{1}{8}$ gallon of urine plus $\frac{1}{8}$ gallon of hay infusion three times a week, September 4 to 20; 1-16 gallon of urine plus 1-16 gallon of hay infusion three times a week, September 21 to October 12; 2-24 gallon of urine plus 1-24 gallon of hay infusion three times a week, October 13 to November 3; $\frac{1}{8}$ gallon of urine three times a week, November 4 to December 27. Surface raked 1 inch deep twice each week from May 11 to June 22, and once each week from June 23 to December 27. July 15 to 19, experiment interrupted by freshet. September 3, surface raked 4 inches deep, aud October 13, 3 inches deep.

Filter No. 88.

This filter contains 5 feet in depth of a mixture of sand of an effective size of 0.23 millimeter and iron filings, the proportion being 1 part by volume of iron to 2 parts of sand. The filter was put in operation the first week of July, and sewage applied at the rate of 70,000 gallons per acre daily. Nitrification became active within a short period, and the effluent of the filter was of a very satisfactory quality. The rate of operation was increased during October and again during November, making the average rate for the year 89,400 gallons per acre daily. At this rate the effluent has been of a quality that would be expected from a new sand filter, and the presence of the iron within the filter has apparently had no effect upon the purification obtained.

Effluent of Filter No. 88.

1897.	Quantity Applied. — Gallons per Acre Daily for Six Days in a Week.	Temperature. Deg. F.		Length of Time Sewage Remained on Surface. — Minutes.	Appearance.		Ammonia.		Chlorine.	Nitrogen as		Oxygen Consumed.	Bacteria per Cubic Centimeter.
		Sewage.	Effluent.		Turbidity.	Color.	Free.	Albuminoid.		Nitrates.	Nitrites.		
July, . .	70,000	72	65	7m.	V. slight.	.07	.5000	.0340	6.67	0.32	.0160	.07	300,000
August, .	70,000	71	70	3m.	V. slight.	.18	.4350	.0290	8.94	3.31	.0395	.12	15,800
September,	70,000	67	72	2m.	V. slight.	.15	.1000	.0160	7.12	3.17	.0050	.06	2,000
October, .	96,000	57	60	10m.	V. slight.	.24	.2000	.0160	9.88	3.46	.0125	.08	2,750
November, .	115,000	47	55	17m.	None.	.09	.6300	.0190	9.30	3.32	.0115	.12	1,000
December, .	115,600	45	50	10m.	V. slight.	.14	.0597	.0080	4.29	2.00	.0048	.12	400
Average,	89,400	60	62	8m.	–	.15	.3208	.0203	7.70	2.60	.0149	.10	60,300

Seven pounds 5 ounces of sewage applied six times a week, July 20 to October 13; 12 pounds of sewage six times a week, October 14 to December 31. Surface raked 3 inches deep once each week.

Straining through Coke, followed by Double Filtration through Sand.

Coke Strainer B and Filters Nos. 92 and 93.

This combination of a coke strainer with two sand filters has been described quite fully on page 424. The following tables show the rate of operation of the strainer and filters, together with the results of the analyses of the effluent. As has been stated on the pages referred to, this scheme is really a double straining of sewage, followed by filtration through the lower sand filter. The upper sand filter acted as a strainer without nitrification during the period of its operation. The filters were stopped during December, owing to the fact that it had been amply demonstrated by this time that the scheme was not a feasible or economical one in sewage purification. These filters contained sand of an effective size of 0.43 millimeter.

Effluent of Coke Strainer.

1897.	Quantity Applied. — Gallons per Acre Daily for Six Days in a Week.	Temperature Deg. F.		Appearance.		Ammonia.			Chlorine.	Nitrogen as		Oxygen Consumed.	Bacteria per Cubic Centimeter.
							Albuminoid.						
		Sewage.	Effluent.	Turbidity.	Color.	Free.	Total.	In Solution.		Nitrates.	Nitrites.		
September,	3,575,000	66	62	Decided.	.98	2.33	.3240	.1700	6.29	.02	.0058	1.70	1,328,000
October, .	2,299,000	57	59	Great.	.97	4.55	.7825	.3875	11.26	.05	.0117	3.90	4,313,000
November,	2,945,000	49	48	Great.	.68	2.88	.5867	.3333	6.58	.06	.0047	4.03	2,073,000
December,	4,293,000	49	47	Great.	.59	2.78	.5400	.2800	5.29	.04	.0020	3.50	1,500,000
Average,	3,278,000	55	54	–	.81	3.16	.5583	.2927	7.36	.04	.0061	3.28	2,304,000

Effluent of Filter No. 92.

[Parts per 100,000.]

1897.	Quantity Applied. — Gallons per Acre Daily for Six Days in a Week.	Temperature Deg. F.		Appearance.		Ammonia.		Chlorine.	Nitrogen as		Oxygen Consumed.	Bacteria per Cubic Centimeter.
		Sewage.	Effluent.	Turbidity.	Color.	Free.	Albuminoid.		Nitrates.	Nitrates.		
September, .	894,000	62	62	Decided.	0.83	3.22	.3073	8.60	.12	.0730	1.48	1,213,000
October, . .	575,000	59	64	Great.	0.82	4.85	.4050	10.74	.21	.0210	1.83	1,193,000
November, .	736,000	48	50	Great.	1.21	3.67	.4167	7.31	.24	.0077	2.43	1,263,000
December, .	1,073,000	47	46	Great.	0.50	3.08	.3700	6.35	.12	.0053	1.61	473,000
Average, .	820,000	54	56	-	0.84	3.71	.3748	8.25	.17	.0268	1.84	1,036,000

Filter started September 2. Twenty-inch tank 2½ feet high, bottom perforated with ¼-inch holes, ½ inch apart, 18 inches of sand over gravel underdrains. September 15 to October 9, surface raked 1 inch deep daily; October 10 to December 31, surface raked 3 inches deep daily; November 5, 3 inches of sand removed; December 2, 1 inch of sand removed; December 15, 3 inches of sand removed.

Effluent of Filter No. 93.

[Parts per 100,000.]

1897.	Quantity Applied — Gallons per Acre Daily for Six Days in a Week.	Temperature. Deg. F.		Appearance.		Ammonia.		Chlorine.	Nitrogen as		Oxygen Consumed.	Bacteria per Cubic Centimeter.
		Sewage.	Effluent.	Turbidity.	Color.	Free.	Albuminoid.		Nitrates.	Nitrites.		
September, . .	737,000	62	62	Decided.	.48	2.41	.2137	10.65	0.97	.3729	1.25	455,000
October, . .	474,000	64	61	Decided.	.44	3.04	.1655	10.06	1.91	.1125	0.89	378,000
November, . .	607,000	50	49	Great.	.48	2.08	.1493	9.15	1.89	.1227	1.00	340,000
December, . .	885,500	46	46	Great.	.50	2.04	.1547	5.82	1.23	.1669	1.00	326,000
Average, .	676,000	56	55	-	.48	2.39	.1708	8.92	1.50	.1938	1.04	375,000

Twenty-two inch tank, 2½ feet high, with faucet in bottom. Twelve inches of sand over gravel underdrains. Effluent of Filter No. 92 falls on the surface of Filter No. 93 after dropping 2½ feet through the air. Surface raked 1 inch deep on the following dates: October 5, 25, November 18, 30, December 6, 10, 13, 15, 16 and 27. December 16, 1 inch of sand removed.

Filter No. 95.

Filter No. 95 contains 4½ feet in depth of ashes from the combustion of soft coal, and was put in operation during the last part of October. The rate of filtration maintained has been 100,000 gallons per acre daily, with the results shown by the following table: —

Effluent of Filter No. 95.

[Parts per 100,000.]

1897.	Quantity Applied. — Gallons per Acre Daily for Six Days in a Week.	Temperature. Deg. F.		Appearance.		Ammonia.		Chlorine.	Nitrogen as		Oxygen Consumed.	Bacteria per Cubic Centimeter.
		Sewage.	Effluent.	Turbidity.	Color.	Free.	Albuminoid.		Nitrates.	Nitrites.		
November, . .	100,000	47	49	None.	.04	.3433	.0213	8.78	3.33	.0467	.10	14,000
December, . .	100,000	45	47	None.	.02	.0300	.0107	5.53	2.24	.0014	.07	673
Average, .	100,000	50	48	None.	.03	.1867	.0160	7.16	2.79	.0241	.09	7,337

Sewage applied, 5 gallons six times a week from October 7 to December 31. Surface raked 3 inches deep once each week.

FILTRATION OF WATER.

The investigations upon the purification of water by sand filtration have been continued throughout the year. Ten experimental sand filters have been in operation, and a large number of chemical and bacterial analyses of the water applied to and the effluent from these filters has been made. To five of the filters Merrimack River water has been applied, and to the remainder, water has been applied which has been made more polluted than the river water, either by adding a small proportion of sewage or allowing bacterial growths to take place within it before filtration.

Besides determining the efficiency of the filters in the usual manner by analyses showing the percentage of organic matter and the total number of bacteria removed during filtration, special tests have been begun to show the percentage removal of *B. coli communis*, the characteristic sewage bacteria, always present in Merrimack River water and of course present in larger numbers in the water rendered more polluted by the addition of more sewage than the river water contains. The efficiency in this respect of continuous and intermittent filters is being particularly studied, and also the efficiency of the Lawrence city filter, 2.5 acres in area, which supplies the city with filtered water. Only the Lawrence filter results in this line of work are given in this report, it being thought better to wait until more results from the experimental filters were obtained before publishing. The study of the efficiency of the Lawrence city filter from a hygienic stand-point has also been continued, and a table is given showing its effect upon the typhoid fever death-rate of the city of Lawrence.

Application of Bacillus Prodigiosus.

Bacillus prodigiosus has been mixed with the water applied to filters Nos. 3 B, 7 A, 8 A, 68, 69, 79 and 90 at different periods from July to November. The general plan of the experiments has been the same as in previous years. This mixture has been applied

to the filters in the proportion of 1 part of solution in 85,000 parts of applied water, at intervals of one hour for ten hours daily for six days in the week, as follows: to filters No. 3 B, 7 A and 8 A from July 20 to October 1; to filters Nos. 68 and 69 from July 20 to October 27; to Filter No. 86 from July 20 to September 27; to Filter No. 79 from August 23 to September 20; to Filter No. 90 from October 1 to October 27.

Numerous examinations of the effluents have been made to determine whether this germ passed through the filters. In addition to the regular methods of examination, roll cultures in four liter bottles (see annual report of the Board for 1895, page 597) were made from time to time. By this method, 50 cubic centimeters of the water could be examined at one time; but in no case, when so examined, was the germ found, although occasional colonies appeared on the plates.

The following table gives the number present in the water applied to the filters, and the number found in the various effluents is given with the tables giving the total number of bacteria of all kinds found in the effluents. It will be seen that all the filters removed a much greater percentage of this germ than of the river bacteria.

Average Number per Cubic Centimeter of Bacillus Prodigiosus in Applied Water for Ten Hours Daily, 1897.

Day of Month.	July.	August.	September.	October.
1,	-	-	902	1,344
2,	-	106	891	637
3,	-	71	625	-
4,	-	59	374	637
5,	-	82	-	999
6,	-	282	-	613
7,	-	24	24	366
8,	-	-	35	311
9,	-	106	130	141
10,	-	35	-	-
11,	-	47	-	757
12,	-	118	-	517
13,	-	141	-	952
14,	-	224	-	1,300
15,	-	-	47	3,032

Average Number per Cubic Centimeter of Bacillus Prodigiosus in Applied Water for Ten Hours Daily, 1897 — Concluded.

Day of Month.	July.	August.	September.	October.
16,	-	59	397	1,215
17,	-	271	844	-
18,	-	436	625	649
19,	-	436	-	2,106
20,	95	1,333	745	1,239
21,	130	460	248	625
22,	95	-	637	2,024
23,	164	483	1,072	820
24,	130	448	495	-
25,	-	566	661	1,300
26,	118	566	-	1,095
27,	12	1,160	566	1,404
28,	59	566	472	-
29,	47	-	1,227	-
30,	24	1,074	757	-
31,	59	844	-	-

Filtration of Merrimack River Water.

The largest experimental filters to which river water has been applied during the year are filters Nos. 3 B, 7 A and 8 A, each being $\frac{1}{200}$ of an acre in area, all the remaining experimental filters described in this report upon water filtration being $\frac{1}{20000}$ of an acre in area. The two following tables present the average chemical analyses of the weekly samples of river water, together with the daily number of bacteria contained by it.

The daily average number of bacteria given in this table, and in all the tables showing the number of bacteria present in the effluents of the experimental filters, is the average of at least two and sometimes three samples collected at different hours of the day.

Average Number of Bacteria per Cubic Centimeter in the Canal Water (Merrimack River), 1897.

Day of Month.	January.	February.	March.	April.	May.	June.	July.	August.	September.	October.	November.	December.
1,	9,400	8,850	7,900	2,700	7,800	4,500	10,900	–	2,600	22,900	8,500	2,700
2,	11,900	7,150	9,300	1,650	–	3,800	6,400	1,600	5,100	22,000	4,600	6,600
3,	–	6,050	7,300	6,400	4,100	2,200	8,500	2,600	98,600	–	12,300	–
4,	6,900	8,100	13,900	–	7,350	4,400	–	5,200	4,700	3,500	7,400	2,900
5,	10,500	5,800	11,600	5,150	3,350	6,100	–	27,500	–	2,800	8,400	–
6,	16,500	8,900	11,700	3,350	1,700	–	2,900	10,300	–	6,400	6,200	5,500
7,	8,900	–	–	5,000	3,950	3,200	33,700	10,800	12,900	5,600	–	3,400
8,	12,300	16,500	11,400	4,000	3,800	2,500	20,000	–	21,000	14,900	3,900	7,500
9,	9,800	10,000	8,100	10,950	–	3,400	30,900	3,200	13,200	3,600	3,900	900
10,	–	9,050	7,200	7,200	3,400	4,100	12,200	2,600	52,300	–	3,700	4,300
11,	10,400	13,950	9,700	–	7,750	4,200	–	9,500	12,800	9,700	3,500	5,400
12,	11,700	9,200	12,700	4,150	6,400	4,400	5,500	8,300	–	9,700	4,100	–
13,	5,100	13,000	11,400	3,150	7,350	–	7,900	7,000	6,200	12,400	4,700	7,500
14,	9,300	–	–	3,350	6,100	2,800	12,800	8,500	4,300	8,600	–	6,200
15,	8,100	11,300	9,200	4,800	8,400	1,500	–	–	7,400	10,300	3,200	6,500
16,	10,700	9,900	8,900	3,300	–	2,600	–	5,400	15,700	12,200	4,800	2,100
17,	–	11,350	6,250	4,500	3,400	5,300	–	6,400	16,700	–	7,000	6,200
18,	12,900	9,150	6,000	–	2,750	1,400	–	10,900	16,200	44,600	6,200	5,500
19,	11,100	11,900	5,850	–	4,450	1,400	8,000	7,500	–	9,300	4,700	–
20,	8,200	7,200	7,700	2,500	3,150	–	3,400	7,100	4,000	29,900	3,500	6,900
21,	7,800	–	–	5,550	5,050	3,600	3,200	18,800	1,400	20,900	–	3,500
22,	5,700	–	7,950	1,950	5,100	1,700	4,700	–	2,300	14,700	1,800	2,700
23,	7,200	6,700	7,650	1,750	–	3,900	3,500	4,400	9,600	13,300	2,500	1,900
24,	–	5,000	8,000	2,200	2,500	5,100	11,200	8,900	8,900	–	3,700	5,200
25,	14,000	5,550	10,700	–	8,100	2,700	–	17,100	9,800	10,100	–	–
26,	7,100	5,700	5,550	1,600	11,900	3,700	3,800	14,100	–	10,900	3,800	–
27,	11,800	9,800	3,550	2,000	9,200	–	2,700	13,900	12,500	5,900	4,500	2,800
28,	11,150	–	–	3,400	6,600	2,800	3,500	5,300	7,900	10,200	–	3,700
29,	8,850	–	2,300	1,600	6,400	5,500	5,000	–	3,100	7,500	8,000	7,600
30,	8,700	–	2,800	2,000	–	9,700	4,000	2,350	12,000	4,000	3,500	9,400
31,	–	–	3,000	–	4,200	–	8,700	4,900	–	–	–	7,600
Average,	9,845	9,135	8,059	3,768	5,548	3,712	9,278	8,621	14,448	12,535	5,136	4,980

Monthly Averages of Analyses of Canal Water (Merrimack River).

[Parts per 100,000.]

1897.	Temperature. — Deg. F.	Color.	Ammonia.			Chlorine.	Nitrogen as		Oxygen Consumed.	Per Cent. of Dissolved Oxygen.	Bacteria per Cubic Centimeter.
			Free.	Albuminoid.			Nitrates.	Nitrites.			
				Total.	Soluble.						
January,	37	.45	.0101	.0223	.0201	.24	.025	.0000	.47	95	9,845
February,	35	.39	.0076	.0198	.0168	.17	.014	.0000	.39	96	9,135
March,	39	.43	.0057	.0193	.0174	.15	.015	.0000	.43	100	8,059
April,	43	.55	.0056	.0182	.0172	.12	.010	.0000	.47	100	3,768
May,	59	.43	.0062	.0215	.0169	.08	.014	.0001	.49	86	5,548
June,	64	.42	.0031	.0163	.0148	.09	.015	.0000	.45	93	3,712
July,	73	.56	.0030	.0167	.0159	.13	.013	.0000	.56	84	9,278
August,	68	.47	.0023	.0163	.0152	.15	.020	.0000	.42	78	8,621
September,	60	.34	.0013	.0147	.0137	.25	.024	.0000	.33	39	14,448
October,	58	.33	.0020	.0147	.0105	.38	.029	.0000	.28	76	12,535
November,	51	.53	.0023	.0187	.0166	.26	.024	.0001	.54	88	5,136
December,	47	.50	.0012	.0128	.0111	.21	.019	.0000	.50	98	4,980
Average,	53	.45	.0042	.0176	.0155	.19	.019	.0000	.44	86	7,922

Filter No. 3 B.

Filter No. 3 B was first put in operation in September, 1893, and the results obtained from it up to Jan. 1, 1897, have been published in previous reports. The filter is $\frac{1}{200}$ of an acre in area, and contained during 1897 approximately 45 inches in depth of sand of an effective size of 0.23 millimeter, and was operated at an average rate of 3,276,000 gallons per acre daily. It is an intermittent filter and its surface is uncovered for two hours each day. Operating at the rate given it was necessary, in order to remove clogging at the surface, to scrape from the filter $\frac{1}{2}$ inch in depth of sand twenty-three times during the year, the dates being given on a following table, showing the volume of water passing between each scraping. The surface of the filter was spaded 4 inches deep on March 11, and 6 inches deep on June 21 and November 18. Always after scraping, the surface was raked to a depth of 1 inch, and the filter filled slowly from below with filtered water.

Owing to the fact that the water was drawn out of the canal from which we obtain our supply of Merrimack River water, the filter

was out of operation for periods varying from three to sixty hours on the following dates: January 5, February 6, 27, March 24, April 10, May 12, 29, June 5, 19, 26, July 3, 10, 24, 31, August 7, 14, 21, 28, September 4, 11, 18, 25, October 2, 9, 16, 23, 30, November 20 and December 4. Owing to high water in the river, the filter was out of operation on the whole or parts of the following days: June 10, 11, 12, 13, 14, 15, July 15, 16, 17, December 15, 16, 17, 18, 19 and 20. This filter has always been operated intermittently, and the following tables present the average chemical analyses of the effluent, together with the daily determinations of the number of bacteria present in the effluent for 1897: —

Average Number of Bacteria per Cubic Centimeter in the Effluent of Filter No. 3 B, 1897.

Day of Month.	January.	February.	March.	April.	May.	June.	July.		August.		September.		October.	November.	December.
							Water Bacteria.	B. Prodigiosus.	Water Bacteria.	B. Prodigiosus.	Water Bacteria.	B. Prodigiosus.			
1,	–	125	231	43	36	18	–	–	–	–	195	0	36	70	45
2,	51	78	50	33	–	16	44	–	20	0	56	0	40	26	66
3,	–	60	30	39	16	27	27	–	17	0	42	0	–	46	112
4,	409	64	–	–	39	19	–	–	7	0	62	0	12	42	74
5,	335	40	429	30	39	26	–	–	30	0	–	–	12	18	–
6,	188	43	325	51	22	–	72	–	27	0	–	–	13	14	103
7,	231	–	–	28	38	–	28	–	84	0	86	0	13	–	71
8,	198	146	–	38	25	18	20	–	–	–	43	0	7	–	54
9,	128	278	184	37	–	20	14	–	–	–	22	0	10	54	62
10,	–	128	115	84	59	21	49	–	62	0	22	0	–	50	56
11,	40	169	90	–	33	–	–	–	31	0	22	0	11	44	45
12,	45	84	219	36	20	–	61	–	50	0	–	–	26	37	–
13,	135	86	372	41	49	–	34	–	66	0	46	0	21	24	100
14,	196	–	–	37	20	–	28	–	23	0	47	0	23	–	72
15,	146	128	253	53	19	16	4	–	–	–	59	0	19	30	–
16,	198	196	187	68	–	33	–	–	25	0	31	0	35	19	–
17,	–	42	131	87	13	28	–	–	42	0	16	0	–	10	–
18,	97	–	95	–	18	16	–	–	43	0	–	–	50	–	–
19,	59	140	76	–	16	16	–	–	12	0	–	–	22	–	–
20,	65	283	56	52	22	–	116	0	40	0	17	0	13	275	73
21,	49	–	–	114	21	–	38	0	92	0	16	0	20	–	55
22,	32	221	98	29	21	–	72	0	–	–	14	0	30	81	19
23,	38	145	56	38	–	42	30	0	49	0	–	–	18	196	–
24,	–	98	62	95	16	47	53	0	75	0	52	0	–	194	–
25,	39	90	–	–	25	28	–	–	103	0	90	1	33	–	–
26,	–	68	73	48	18	31	26	0	–	–	–	–	28	239	–
27,	170	83	98	49	28	–	29	0	102	0	24	1	–	170	253
28,	276	–	–	39	18	61	35	0	154	0	47	0	80	–	248
29,	295	–	53	39	44	29	23	0	–	–	82	0	41	100	338
30,	223	–	34	29	–	19	13	0	99	1	58	0	64	44	140
31,	–	–	44	–	31	–	24	0	71	1	–	–	–	–	237
Average,	152	122	140	49	27	27	38	–	55	–	50	–	27	81	111

Effluent of Filter No. 3 B.

[Parts per 100,000.]

1897.	Quantity of Effluent. — Gallons per Acre Daily.	Temperature. Deg. F.		Color.	Ammonia.		Chlorine.	Nitrogen as		Oxygen Consumed.	Per Cent. of Dissolved Oxygen.	Bacteria per Cubic Centimeter.
		Applied Water.	Effluent.		Free.	Albuminoid.		Nitrates.	Nitrites.			
January, . .	3,885,000	37	35	.39	.0047	.0116	.24	.043	.0000	.36	90	152
February, . .	3,194,000	35	35	.35	.0026	.0106	.19	.031	.0000	.25	86	122
March, . .	3,623,000	39	37	.34	.0015	.0118	.17	.020	.0000	.35	89	140
April, . .	3,949,000	43	41	.48	.0010	.0114	.14	.035	.0000	.43	87	49
May, . . .	3,438,000	59	59	.29	.0016	.0098	.12	.032	.0000	.33	71	27
June, . .	3,390,000	64	71	.35	.0020	.0092	.10	.020	.0000	.34	68	27
July, . . .	2,349,000	73	75	.46	.0032	.0122	.15	.023	.0000	.43	78	38
August, . .	2,825,000	68	72	.34	.0009	.0099	.14	.024	.0000	.34	78	55
September, .	2,741,000	60	67	.17	.0004	.0060	.21	.046	.0000	.24	64	50
October, . .	2,789,000	58	59	.18	.0015	.0069	.38	.046	.0000	.19	73	27
November, .	3,347,000	51	45	.43	.0015	.0128	.27	.028	.0000	.45	95	81
December, .	3,781,000	47	36	.38	.0004	.0074	.21	.030	.0000	.40	90	111
Average, .	3,276,000	53	53	.35	.0018	.0100	.19	.032	.0000	.34	81	73

Filter No. 7 A.

Filter No. 7 A is a continuous filter and was first put in operation during September, 1893, and the results obtained up to Jan. 1, 1897, have been published in previous reports. This filter is $\frac{1}{200}$ of an acre in area, and contained during most of the year 1897 approximately 20 inches in depth of sand of an effective size of 0.26 millimeter, but during part of the year a much less depth of sand. The average rate of filtration for the year has been 3,654,000 gallons per acre daily. In order to maintain this rate the filter has had to be scraped, and $\frac{1}{2}$ inch of sand removed, eleven times during the year. The dates of scraping, together with the volume of water passing between each scraping, are shown by the table on page 472. Besides these scrapings, the surface was spaded over 6 inches deep on January 16 and November 7. It was also raked 1 inch deep on February 4, March 11, June 3 and July 2. After scraping, the surface was always raked 1 inch deep, and the filter was then filled slowly from below with filtered water.

Upon April 26 the depth of sand had become so reduced by the

many scrapings that the filter was refilled; that is, 15 inches of clean sand were mixed with the remaining sand in the filter in the following manner: above the gravel underdrains were placed 2 inches of the coarse sand always placed over the finer gravel; above this, 15 inches of new sand; then 2 inches of mixed clean and dirty sand; and above this, 7 inches of the sand previously in the filter. Filtered water was applied slowly from below after this reconstruction, and the filter allowed to stand covered with water for twenty-four hours before filtration was started. The filter was out of operation on account of low water in the canal or high water in the river upon the same dates during the year that were given in the description of the operation of Filter No. 3 B. The following tables give the average chemical analyses of the effluent of this filter, together with the results of the daily determinations of the number of bacteria present in the effluent for 1897: —

Average Number of Bacteria per Cubic Centimeter in Effluent of Filter No. 7 A, 1897.

Day of Month.	January.	February.	March.	April.	May.	June.	July.		August.		September.		October.	November.	December.
							Water Bacteria	B. Prodigiosus.	Water Bacteria.	B. Prodigiosus.	Water Bacteria.	B. Prodigiosus.			
1, ...	98	59	61	63	–	52	27	–	–	–	49	1	83	113	19
2, ...	87	54	173	41	–	35	25	–	41	0	72	0	41	10	32
3, ...	–	429	236	39	–	34	131	–	14	0	31	0	–	63	126
4, ...	36	–	502	–	–	29	–	–	11	0	31	0	310	65	69
5, ...	26	–	704	30	–	35	–	–	20	0	–	–	20	105	–
6, ...	129	1,670	560	29	–	–	101	–	14	0	–	–	25	18	96
7, ...	29	–	–	45	–	85	21	–	44	1	57	0	32	–	65
8, ...	22	1,792	262	51	4,600	40	16	–	–	–	20	0	13	18	72
9, ...	18	1,477	131	44	–	27	11	–	40	0	17	0	13	13	107
10, ...	–	1,083	127	42	4,900	28	14	–	23	0	18	0	–	44	60
11, ...	19	1,071	126	–	1,100	–	–	–	–	–	26	0	212	37	39
12, ...	19	898	95	83	2,674	–	53	–	68	0	–	–	29	17	–
13, ...	22	1,327	101	34	850	–	13	–	33	0	85	0	30	20	154
14, ...	25	–	–	32	250	–	13	–	29	0	12	0	17	–	171
15, ...	52	632	139	36	104	93	–	–	–	–	13	0	24	36	24
16, ...	33	287	138	18	–	43	–	–	52	0	19	0	23	45	–
17, ...	–	334	142	37	89	40	–	–	15	0	10	0	–	–	–
18, ...	2,143	256	118	–	38	23	–	–	17	0	12	0	287	–	–
19, ...	2,714	175	102	–	50	55	–	–	11	0	–	–	42	83	–
20, ...	1,806	259	77	72	41	–	24	0	14	0	102	1	123	89	187
21, ...	2,099	–	–	72	55	64	–	–	24	0	18	1	210	–	73
22, ...	1,297	–	151	43	25	27	92	1	–	–	70	1	144	96	75
23, ...	1,176	64	88	50	–	54	92	0	55	1	31	0	94	95	110
24, ...	–	70	133	63	28	62	51	2	19	0	49	0	–	83	87
25, ...	536	63	–	–	22	41	–	–	16	1	38	0	651	–	–
26, ...	173	48	132	67	50	65	121	2	21	0	–	–	72	64	–
27, ...	160	74	96	35	48	–	22	0	12	0	129	0	29	53	165
28, ...	107	–	–	66	97	100	36	0	13	0	33	0	31	–	90
29, ...	101	–	71	–	160	30	13	0	–	–	105	1	20	23	86
30, ...	87	–	57	–	–	23	16	0	85	0	157	2	24	17	38
31, ...	–	–	46	–	78	–	24	0	28	0	–	–	–	–	36
Average, .	501	577	176	47	763	47	44	–	29	–	52	–	100	52	86

Effluent of Filter No 7 A.

[Parts per 100,000.]

1897.	Quantity of Effluent. — Gallons per Acre Daily.	Temperature. Deg. F.		Color.	Ammonia.		Chlorine.	Nitrogen as		Oxygen Consumed.	Per Cent. of Dissolved Oxygen.	Bacteria per Cubic Centimeter.
		Applied Water.	Effluent.		Free.	Albuminoid.		Nitrates.	Nitrites.			
January, . .	2,674,000	37	35	.40	.0049	.0137	.24	.037	.0000	.38	70	501
February, . .	3,265,000	35	34	.35	.0030	.0142	.19	.023	.0000	.30	77	577
March, . .	2,940,000	39	38	.34	.0008	.0116	.15	.014	.0000	.34	82	176
April, . .	1,743,000	43	41	.46	.0026	.0122	.14	.056	.0000	.37	58	47
May, . . .	4,116,000	59	56	.36	.0019	.0115	.12	.035	.0000	.38	59	763
June, . .	4,079,000	64	70	.35	.0018	.0098	.09	.021	.0000	.34	68	47
July, . . .	3,316,000	73	73	.45	.0024	.0128	.14	.046	.0000	.44	29	44
August, . .	4,292,000	68	73	.37	.0011	.0107	.11	.021	.0000	.38	46	29
September, .	4,306,000	60	68	.19	.0005	.0078	.21	.034	.0000	.25	30	52
October, . .	3,978,000	58	58	.19	.0010	.0077	.37	.031	.0000	.20	39	100
November, .	4,094,000	51	45	.38	.0015	.0115	.27	.041	.0000	.41	76	52
December, .	5,050,000	47	34	.42	.0011	.0083	.21	.022	.0000	.47	86	86
Average, .	3,654,000	53	52	.36	.0019	.0110	.19	.032	.0000	.35	60	204

Filter No. 8 A.

Filter No. 8 A is a duplicate in construction of Filter No. 3 B. It is $\frac{1}{200}$ of an acre in area, was first put in operation in September, 1893, and during 1897 it contained approximately 45 inches in depth of sand with an effective size of 0.23 millimeter. Filter No. 3 B is an intermittent filter, however, while Filter No. 8 A has always been operated continuously. During 1897 the average rate of filtration has been 4,247,000 gallons per acre daily. In order to maintain this rate, the surface of the filter has been scraped, and $\frac{1}{2}$ inch of sand removed at each scraping, sixteen times, upon the dates given on the table on page 471. Besides these scrapings, the surface of the filter has been spaded 6 inches deep June 21 and November 4. Always after scraping, the surface has been raked to the depth of 1 inch, and the filter then filled slowly from below with filtered water.

The filter has been out of operation on account of low water in the canal or high water in the river upon the same dates mentioned in the description of the operation of Filter No. 3 B. The following tables give the average chemical analyses of the effluent of this filter, together with daily determinations of the number of bacteria present in this effluent for 1897 : —

Average Number of Bacteria per Cubic Centimeter in the Effluent of Filter No. 8 A, 1897.

Day of Month.	January.	February.	March.	April.	May.	June.	July.		August.		September.		October.	November.	December.
							Water Bacteria.	B. Prodigiosus.	Water Bacteria.	B. Prodigiosus.	Water Bacteria.	B. Prodigiosus.			
1, ...	51	114	46	33	38	22	28	–	–	–	40	0	7	23	6
2, ...	52	72	52	32	–	18	10	–	23	0	13	0	14	10	10
3, ...	–	66	76	45	11	13	17	–	10	0	13	0	–	17	7
4, ...	22	55	73	–	27	21	–	–	10	0	17	0	18	46	14
5, ...	33	37	109	25	16	32	–	–	28	0	–	–	11	–	–
6, ...	52	33	133	27	20	–	83	–	12	0	–	–	5	24	66
7, ...	43	–	–	29	45	–	18	–	26	0	270	0	30	–	20
8, ...	85	116	75	35	10	23	11	–	–	–	10	0	52	51	17
9, ...	109	60	46	45	–	19	7	–	–	–	19	0	15	35	41
10, ...	–	–	92	27	80	10	28	–	10	0	11	0	–	35	31
11, ...	52	30	51	–	12	–	–	–	13	0	7	0	20	28	16
12, ...	59	33	58	66	25	–	64	–	23	0	–	–	17	24	–
13, ...	6	39	38	40	13	–	10	–	20	0	260	0	16	16	11
14, ...	42	–	–	26	28	–	20	–	37	0	11	0	23	–	28
15, ...	91	49	72	32	37	64	–	–	–	–	17	0	14	28	–
16, ...	115	44	58	20	–	39	–	–	54	0	44	0	17	28	–
17, ...	–	55	53	24	26	17	–	–	58	0	11	0	–	17	–
18, ...	75	68	76	–	14	13	–	–	16	0	19	0	111	13	–
19, ...	75	118	61	–	15	23	–	–	–	–	–	–	18	12	–
20, ...	62	122	96	32	20	–	12	0	26	0	127	0	16	52	40
21, ...	60	–	–	65	26	–	13	0	48	0	23	0	9	–	95
22, ...	30	104	118	65	24	–	20	0	–	–	18	1	13	61	33
23, ...	113	81	76	43	–	65	25	0	116	0	15	0	17	25	29
24, ...	–	–	70	45	28	14	17	0	12	0	19	1	–	25	26
25, ...	57	54	–	–	57	21	–	–	20	0	65	0	106	–	–
26, ...	51	36	87	26	20	20	78	0	19	0	–	–	17	16	–
27, ...	23	34	62	42	18	–	12	0	15	0	85	0	25	50	22
28, ...	49	–	–	56	11	64	24	0	27	0	9	0	10	–	20
29, ...	120	–	42	18	14	18	18	0	–	–	6	0	9	9	43
30, ...	124	–	43	46	–	48	16	0	33	0	5	0	10	8	24
31, ...	–	–	34	–	21	–	12	0	17	0	–	–	–	–	10
Average, . .	63	65	69	38	25	28	25	–	28	–	45	–	24	27	28

Effluent of Filter No. 8 A.

[Parts per 100,000]

1897.	Quantity of Effluent. — Gallons per Acre Daily.	Temperature. Deg. F.		Color.	Ammonia.		Chlorine.	Nitrogen as		Oxygen Consumed.	Per Cent of Dissolved Oxygen.	Bacteria per Cubic Centimeter.
		Applied Water.	Effluent.		Free.	Albuminoid.		Nitrates.	Nitrites.			
January, . .	3,687,000	37	35	.38	.0041	.0111	.24	.044	.0000	.35	82	63
February, .	3,095,000	35	34	.35	.0020	.0096	.18	.030	.0000	.26	71	65
March, . .	3,856,000	39	37	.32	.0020	.0117	.15	.045	.0000	.32	79	69
April, . .	4,581,000	43	52	.29	.0012	.0094	.11	.025	.0000	.31	74	38
May, . . .	4,268,000	59	58	.28	.0017	.0094	.11	.035	.0000	.31	59	25
June, . .	4,089,000	64	70	.35	.0044	.0096	.10	.021	.0000	.34	50	28
July, . . .	4,505,000	73	75	.43	.0020	.0104	.14	.024	.0000	.41	24	25
August, . .	4,502,000	68	72	.34	.0007	.0095	.15	.022	.0000	.35	43	28
September, .	4,539,000	60	69	.19	.0008	.0069	.22	.035	.0000	.22	42	45
October, . .	3,818,000	58	58	.18	.0010	.0072	.37	.029	.0000	.19	33	24
November, .	5,693,000	51	44	.43	.0011	.0119	.27	.032	.0000	.45	75	27
December, .	4,332,000	47	37	.35	.0007	.0080	.21	.034	.0000	.36	80	28
Average, .	4,247,000	53	53	.32	.0018	.0096	.19	.031	.0000	.32	59	39

Review of Results obtained during 1897 from Filters Nos. 3 B, 7 A and 8 A.

The following table gives the average chemical analysis for the year of the water applied to these filters and the average chemical analysis of their effluents, together with the average number of bacteria present and the average rate of filtration of the filters in gallons per acre daily : —

	Rate of Filtration. — Gallons per Acre Daily.	Turbidity.	Color.	Ammonia.		Chlorine.	Nitrogen as		Oxygen Consumed.	Bacteria per Cubic Centimeter.
				Free.	Albuminoid.		Nitrates.	Nitrites.		
River water, ...	–	Slight.	.45	.0042	.0176	.19	.019	.0000	.44	7,922
Effluent of Filter No. 3 B, .	3,276,000	None.	.35	.0018	.0100	.19	.032	.0000	.34	73
Effluent of Filter No. 8 A, .	4,247,000	None.	.32	.0018	.0096	.19	.031	.0000	.32	39
Effluent of Filter No. 7 A, .	3,654,000	None.	.36	.0019	.0110	.19	.032	.0000	.35	204

The table shows that the two filters containing the greatest depth of sand have given the best results, both from a chemical and bacterial point of view, although Filter No. 7 A containing only about one-third as great a depth of sand as the other two filters, has given an effluent containing very little more color and organic matter than the effluent of the deeper filters.

The average number of bacteria in the applied river water has been 7,922 per cubic centimeter, the highest daily average occurring in September, when 14,448 bacteria per cubic centimeter were found, and the least number in June, when only 3,712 were present per cubic centimeter. The average number of bacteria in the effluent of Filter No. 3 B has been 73 per cubic centimeter, giving an average bacterial efficiency for this filter of 99.08 per cent. The effluent of Filter No. 7 A has contained on an average 204 bacteria per cubic centimeter, giving an average bacterial efficiency for the year of 97.43 per cent., while the effluent of Filter No. 8 A has contained only 39 bacteria per cubic centimeter, giving an average bacterial efficiency of 99.49 per cent. It must be stated, however, that Filter No. 7 A during the seven months following its reconstruction gave an effluent containing on an average only 59 bacteria per cubic centimeter.

During the period of the year from April to November inclusive, the average efficiency of filters Nos. 3 B and 8 A was nearly equal, but during the four cold months of January, February, March and December, the efficiency of Filter No. 8 A was greater than that of Filter No. 3 B, which, being operated intermittently, had its surface exposed to the cold each day; the highest average number of bacteria per cubic centimeter for any of these three months in the effluent from Filter No. 8 A being 69, while the highest average number of bacteria in the effluent from Filter No. 3 B for any month was 152.

Volume of Water passing through Filters Nos. 3 B, 7 A and 8 A between Times of Scraping.

The average rate of filtration of Filter No. 3 B for the year has been 3,276,000 gallons per acre daily; of Filter No. 7 A, 3,654,000 gallons per acre daily; and of Filter No. 8 A, 4,247,000 gallons per acre daily. Filters Nos. 7 A and 8 A are continuous filters, while Filter No. 3 B is an intermittent filter; that is to say, in operating Filter No. 3 B the water is drawn down and the filter allowed to drain to such an extent that its surface is uncovered and free from

water for two hours daily. Filters Nos. 3 B and 8 A contain the same depth and kind of sand, namely, approximately 45 inches, with an effective size of 0.23 millimeter, while Filter No. 7 A contains 20 inches in depth of sand of an effective size of 0.26 millimeter. Operating at the rates given, it has been necessary, in order to maintain this rate of operation, to scrape Filter No. 3 B twenty-three times during the year, Filter No. 7 A eleven times and Filter No. 8 A sixteen times. The depth of water over the surface of filters Nos. 3 B and 8 A has averaged 15 inches for the entire year. The depth of water over the surface of Filter No. 7 A has varied from time to time, the greatest depth maintained being from November 15 to November 18, 27 inches, and the least depth from November 19 to December 1, 10 inches; the average depth for the year being 17 inches. As stated before, almost the entire depth of sand in Filter No. 7 A was new, clean sand placed there during the last part of April, 1897, while the sand in filters Nos. 3 B and 8 A was placed in the filters during September, 1893, and has since been in continuous use, these filters having had no period of rest except a few days, when they were out of operation from time to time, owing to low water in the canal or high water in the river.

On referring to the records of these filters for the year 1896, we find that Filter No. 7 A, containing sand during that year which had been in use for four years, was scraped fourteen times during its period of operation of nine months in 1896, while Filter No. 8 A operating at approximately the same rate during this period had to be scraped only eleven times; the comparison of the two years operation of Filter No. 7 A, show plainly the greater ease with which water passed through the clean sand present in the filter during 1897 than it did through the sand which had become more or less clogged from use during 1893, 1894, 1895 and 1896. On comparing filters Nos. 3 B and 8 A in this respect, it is seen that the continuous filter was scraped many less times during the year, although operated at the greater rate. It can be said moreover that, while it was the constant effort to operate Filter No. 3 B at a rate equal to 8 A, this was impossible, for reasons stated on page 516 in the report of 1896. On consulting the tables it will be found that very varying volumes of water pass through each of these filters during periods between scrapings, owing largely to the different character of the water applied to the filters; that is, the varying quantity and quality of the matters in suspension in this water at different seasons of the year.

Filter No. 3 B.

Date of Scraping.	Actual Number of Gallons filtered between Scrapings.	Number of Gallons filtered between Scrapings (per Acre of Filter Surface.)	Date of Scraping.	Actual Number of Gallons filtered between Scrapings.	Number of Gallons filtered between Scrapings (per Acre of Filter Surface.)
1897.			1897.		
Jan. 12, . .	209,798	41,959,600	June 2, . .	271,914	54,382,800
Jan. 25, . .	238,606	47,721,200	June 21, . .	213,552	42,710,400
Feb. 6, . .	205,066	41,013,200	July 1, . .	147,893	29,578,600
Feb. 17, . .	137,202	27,440,400	July 20, . .	151,049	30,209,800
March 3, . .	189,878	37,975,600	Aug. 4, . .	166,341	33,268,200
March 8, . .	85,508	17,101,600	Aug. 26, . .	262,857	52,571,400
March 24, . .	310,787	62,157,400	Sept. 22, . .	296,849	59,369,800
March 30, . .	87,438	17,487,600	Oct. 27, . .	410,418	82,083,600
April 5, . .	109,268	21,853,600	Nov. 8, . .	113,518	22,703,600
April 23, . .	322,872	64,574,400	Nov. 18, . .	103,919	20,783,800
May 6, . .	205,306	41,061,200	Dec. 23, . .	445,117	89,023,400
May 17, . .	198,092	39,618,400			

The surface was raked 1 inch deep May 27 and June 16, and spaded over to the depth of 6 inches November 18.

Filter No. 8 A.

Date of Scraping.	Actual Number of Gallons filtered between Scrapings.	Number of Gallons filtered between Scrapings (per Acre of Filter Surface.)	Date of Scraping.	Actual Number of Gallons filtered between Scrapings.	Number of Gallons filtered between Scrapings (per Acre of Filter Surface.)
1897.			1897.		
Jan. 5, . .	762,495	152,499,000	June 21, . .	377,056	75,411,200
Jan. 23, . .	353,319	70,663,800	Aug. 19, . .	1,055,839	211,167,800
Feb. 9, . .	276,847	55,369,400	Sept. 15, . .	467,734	93,546,800
Feb. 23, . .	179,782	35,956,400	Oct. 6, . .	403,161	80,632,200
March 15, . .	264,249	52,849,800	Oct. 26, . .	306,766	61,353,200
April 17, . .	676,345	135,269,000	Nov. 4, . .	99,696	19,939,200
May 12, . .	559,135	111,827,000	Dec. 14, . .	891,066	178,213,200
May 25, . .	241,580	48,316,000	Dec. 22, . .	26,621	5,324,200

The surface was spaded over 6 inches deep November 4.

Filter No. 7 A.

Date of Scraping.	Actual Number of Gallons filtered between Scrapings.	Number of Gallons filtered between Scrapings (per Acre of Filter Surface.)	Date of Scraping.	Actual Number of Gallons filtered between Scrapings.	Number of Gallons filtered between Scrapings (per Acre of Filter Surface.)
1897.			1897.		
Jan. 16, . .	499,582	99,916,400	Sept. 28, . .	468,292	93,658,400
March 16, . .	923,385	184,677,000	Oct. 19, . .	344,718	68,943,600
May 27, . .	825,047	165,009,400	Nov. 9, . .	354,829	70,965,800
July 21, . .	700,291	140,058,200	Nov. 17, . .	108,063	21,612,600
Aug. 10, . .	335,922	67,184,400	Dec. 11, . .	404,331	80,866,200
Aug. 31, . .	372,574	74,514,800			

The surface was raked 1 inch deep February 4, March 1, June 23 and July 2. It was spaded over 6 inches deep November 17.

THE EFFECT UPON BACTERIAL EFFICIENCY — RECKONED BY PERCENTAGES — OF INCREASED NUMBERS OF BACTERIA IN THE APPLIED WATER.

It is customary to show the results of the operation of a filter by a calculation of the percentage of bacteria removed from the applied water by that filter. It is more satisfactory, however, to know the actual number of bacteria present in the effluent. A study of the results obtained for the year from the three filters, a brief account of which has just been given, shows that, while the highest number of bacteria in the applied water occurred in September and the lowest number in June, yet with filters Nos. 3 B and 8 A, containing the same depth of sand, rather better percentage results were obtained during September than during June, showing that, with these filters and with the kinds of bacteria which we find in the applied water, the increase of bacteria to the number shown by the highest average, namely, 14,448 per cubic centimeter in September, had no effect upon decreasing the average percentage removal of bacteria from the applied water although the actual number of bacteria found in the effluent of each filter was twice as great in September as it was in June.

Two experiments upon this point, by which the bacteria in the applied water were increased, are as follows: in one case the increased number of bacteria was accomplished without increasing the organic matter in the water, and in the other case the organic matter was slightly increased. These two experiments were made with filters Nos. 43 and 90.

Filter No. 43.

Filter No. 43 was first put into operation during 1893, and contained, during 1897, 3 feet in depth of sand with an effective size of 0.26 millimeter. Up to September 1 the water applied to this filter was untreated Merrimack River water, that is, water of exactly the same character and containing the same numbers of bacteria as the water applied to the filters already described, and contained to that date an average 7,500 bacteria per cubic centimeter. The average rate of operation of the filter up to September 1 was 4,500,000 gallons per acre daily.

Beginning September 1, the river water, before being applied to the filter, was allowed to stand in a galvanized-iron tank, the sides of which were exposed to their entire depth to the sun's rays and the generally high temperature of the months of August and September. To the water in this tank was also applied a species of bacillus known as *B. Ramosus.* The application of this bacteria and its growth in the water, together with the multiplication of the kinds of bacteria already in the water, increased the total number to such an extent that during the following six weeks the average number in the water applied to the filter was 74,700 per cubic centimeter, or about ten times as many as during the earlier period from May 1 to August 15. During the first period, the average number of bacteria present in the effluent of the filter was 85 per cubic centimeter, thus giving an average bacterial efficiency for the filter of 98.88 per cent. During the period of application of increased numbers of bacteria, the number in the effluent averaged 224 per cubic centimeter, a number nearly three times as great as previously found in the effluent; but, owing to the greatly increased number in the applied water, the average bacterial efficiency of the filter for the second period, reckoned as percentage of bacteria removed, was increased to 99.70 per cent. The tables showing the daily determinations of the number of bacteria in the applied water during September and in the effluent during the entire period of operation follow. Details of the operation of the filter during the year are as follows: —

The surface was scraped and approximately 0.35 of an inch of sand removed upon the following dates: June 3, July 20, August 3, 13, 27, September 17 and 29. September 8, the rate was reduced to 3,000,000 gallons per acre daily. Owing to low water in the

canal, the filter was out of operation upon the following dates: May 12, 29, June 5, 19, 26, July 3, 10, 24, 31, August 7, 14, 21, 28, September 4, 11, 18 and 25.

Average Number of Bacteria per Cubic Centimeter in Water Applied to Filter No. 43 during September.

Day.	September.	Day.	September.
1,	55,000	16,	116,000
2,	96,000	17,	111,500
3,	73,000	18,	95,000
4,	60,000	19,	-
5,	-	20,	36,500
6,	-	21,	18,800
7,	-	22,	52,000
8,	36,500	23,	59,300
9,	45,300	24,	89,300
10,	62,800	25,	250,000
11,	132,500	26,	-
12,	-	27,	90,500
13,	55,800	28,	112,500
14,	66,300	29,	105,000
15,	96,300	30,	56,800

Average Number of Bacteria per Cubic Centimeter in Effluent of Filter No. 43.

Day.	May.	June.	July.	August.	September.
1,	-	23	19	-	60
2,	-	51	16	198	62
3,	-	48	85	54	66
4,	2,500	32	-	105	116
5,	3,000	32	-	104	-
6,	1,000	-	119	87	-
7,	6,400	126	285	91	-
8,	-	39	77	-	115
9,	-	15	113	38	50
10,	396	73	19	44	34
11,	438	46	-	43	95
12,	141	43	98	99	-
13,	208	-	32	48	266
14,	108	28	344	41	293
15,	100	21	-	-	136

Average Number of Bacteria per Cubic Centimeter in Effluent of Filter No. 43 – Concluded.

Day.	May.	June.	July.	August.	September.
16,	-	30	-	42	144
17,	84	28	-	31	551
18,	66	17	-	28	275
19,	41	21	53	-	-
20,	45	-	40	200	234
21,	34	62	13	133	88
22,	81	31	40	-	179
23,	-	27	33	307	99
24,	27	25	162	328	336
25,	46	38	-	148	185
26,	30	60	185	100	-
27,	20	-	31	63	460
28,	25	72	112	85	480
29,	83	113	35	-	338
30,	-	118	124	137	224
31,	-	-	86	120	-

Filter No. 90.

Upon August 31, Filter No. 90, containing 2 feet in depth of sand with an effective size of 0.23 millimeter, was put into operation, filtering river water at the rate of 3,500,000 gallons per acre daily. This filter, after the end of the period of biological construction, gave an effluent containing no more bacteria per cubic centimeter than we should expect to find in the effluent of a new filter of this depth and character of sand, operating at the rate named. Beginning November 1, a small volume of sewage was added to the applied water, enough to increase the average number of bacteria from about 9,000 to 26,000 per cubic centimeter. Of course, the addition of the sewage slightly increased the amount of organic matter present in the applied water, and hence undoubtedly a more efficient deposit of gelatinous organic matter gathered in the upper few inches of the sand in the filter. Owing to this, although the applied bacteria had been increased three-fold, the number in the effluent was decreased during this month, as shown by a following table; thus differing from the action of Filter No. 43, when increased numbers of bacteria were added without appreciably changing the amount of organic matter in the water applied.

Operating at the rate given and with the quality of water described, it was necessary to scrape the surface of Filter No. 90 and remove approximately 0.3 of an inch of sand upon October 6, 19, 27, November 3, 13, 17 and 28. The following tables give the chemical analyses of the effluent of the filter, together with the number of bacteria present each day in the effluent. During December the filter was used for another experiment, as will be explained on page 486.

Average Number of Bacteria per Cubic Centimeter in Effluent of Filter No. 90, 1897.

Day of Month.	September.	October. Water Bacteria.	October. B. Prodigiosus.	November.	December.
1,	52,000	254	0	911	53
2,	80,000	135	0	99	66
3,	46,000	-	-	82	52
4,	10,400	341	1	97	97
5,	-	103	0	165	-
6,	-	148	1	145	66
7,	7,500	80	1	-	51
8,	2,800	56	1	154	54
9,	3,600	117	0	80	84
10,	3,200	-	-	101	76
11,	900	393	0	123	63
12,	-	477	0	195	-
13,	3,900	74	0	73	54
14,	3,300	132	0	-	172
15,	2,000	100	0	118	151
16,	1,400	736	0	75	73
17,	1,050	-	-	50	66
18,	400	333	2	55	51
19,	-	159	0	72	-
20,	1,700	172	0	31	72
21,	650	313	0	-	109
22,	691	152	0	198	47
23,	217	410	0	103	148
24,	264	-	-	217	182
25,	153	183	1	-	-
26,	-	138	1	269	-
27,	339	99	0	111	59
28,	213	69	0	-	71
29,	218	341	0	256	68
30,	383	143	0	143	54
31,	-	-	-	-	59

Effluent of Filter No. 90.

[Parts per 100,000.]

1897.	Quantity of Effluent. — Gallons per Acre Daily.	Temperature. Deg. F. Applied Water.	Temperature. Deg. F. Effluent.	Color.	Ammonia. Free.	Ammonia. Albuminoid.	Chlorine.	Nitrogen as Nitrates.	Nitrogen as Nitrites.	Oxygen Consumed.	Bacteria per Cubic Centimeter.
September,	3,148,000	60	64	.26	.0041	.0116	.29	.034	.0000	.29	-
October,	3,957,000	58	54	.28	.0038	.0098	.37	.035	.0000	.26	218
November,	5,398,000	51	42	.54	.0078	.0140	.30	.027	.0005	.56	157
December,	3,295,000	53	52	.29	.0007	.0073	.41	.116	.0000	.26	81
Average,	3,950,000	56	53	.34	.0041	.0107	.34	.053	.0001	.34	149

Intermittent and Continuous Filtration of Water more polluted than Merrimack River Water.

In the report of the Board for 1896, a summary was given of the results obtained from three years and three months' operation of filters Nos. 3 B and 8 A, the most important water filters which have been in operation at the station for the past ten years. This summary seemed to show that, with water containing no more organic matter than that flowing in the Merrimack River, and always containing a considerable percentage of dissolved oxygen, as the river water does, continuous filtration is fully as successful and effective as intermittent filtration.

The results of the present year, already given on previous pages, seem to confirm those published in the summary in last year's report. The continuous filter has certainly removed a greater percentage of the total number of bacteria in the river water than has the intermittent filter.

During 1896 two filters were started to learn what results could be obtained by continuous and intermittent filtration of water more polluted than the Merrimack River water. Interesting results obtained from these filters were published in last year's report, and the filters have been continued in operation during 1897. The following tables give the average chemical analyses of the water applied to these filters and the average daily number of bacteria contained in this water. A study of the tables and a comparison with the table showing the average analyses of Merrimack River water, presented on page 462, will show that the water applied to these filters has contained nearly two and one-half times as much organic matter determined as albuminoid ammonia as the river water, and that the free ammonia averaged .1400 of a part, as compared with .0042 of a part in the river water. The organic matter determined as oxygen consumed was only very slightly increased, the bacteria were fully twenty-five times as great in the polluted water as in the river water, and the amount of dissolved oxygen present in this water as it ran upon the filter averaged 70 per cent. of that necessary for saturation.

Average Number of Bacteria per Cubic Centimeter in Water Applied to Filters Nos. 68 and 69, 1897.

Day of Month.	January.	February.	March.	April.	May.	June.	July.	August.	September.	October.	November.	December.
1,	171,000	275,800	122,000	129,000	469,000	146,200	194,000	-	265,000	30,100	78,800	102,000
2,	217,000	260,500	125,000	289,000	-	116,000	110,500	193,500	506,200	19,400	55,800	116,900
3,	-	352,300	141,000	86,000	188,000	52,200	-	268,500	611,200	-	88,800	116,000
4,	143,000	208,000	138,000	-	205,300	126,500	-	368,300	517,500	7,500	57,000	159,000
5,	154,000	215,800	202,000	205,000	174,000	160,000	-	528,800	-	9,100	82,200	-
6,	460,000	211,000	77,000	186,000	229,700	-	200,000	156,300	-	13,900	55,000	26,000
7,	108,000	-	-	142,300	230,300	114,700	265,000	225,800	170,500	12,700	-	100,400
8,	58,000	154,700	143,800	132,700	313,000	122,500	287,000	-	226,700	20,100	-	127,400
9,	43,000	224,700	173,000	75,000	-	128,800	403,200	150,700	624,200	18,300	-	58,000
10,	-	168,300	159,000	124,000	222,700	136,500	390,800	174,600	428,300	-	96,500	194,000
11,	242,000	321,500	146,700	-	227,000	60,000	-	244,800	165,000	9,700	35,800	162,000
12,	223,000	281,000	138,000	60,700	128,000	62,500	191,600	398,900	-	33,400	68,700	-
13,	208,000	279,000	165,500	203,700	186,500	-	118,000	540,000	137,700	38,300	30,000	275,000
14,	83,000	-	-	147,000	173,700	155,000	242,200	59,000	102,500	39,700	-	112,700
15,	118,000	107,700	133,700	161,800	207,000	122,000	-	-	55,700	21,000	36,000	136,000
16,	76,000	150,000	151,300	154,300	-	253,000	-	248,800	44,800	12,900	61,900	143,200
17,	-	225,300	195,000	112,000	139,500	189,000	-	370,400	65,000	-	133,200	148,000
18,	289,000	156,300	90,700	-	157,500	128,000	-	247,500	14,100	80,900	164,900	60,300
19,	265,000	176,000	147,000	-	210,000	-	-	167,300	-	112,300	205,500	-
20,	59,000	114,000	-	185,000	134,000	-	82,500	331,100	10,200	127,800	240,500	51,700
21,	177,000	-	-	184,300	115,200	189,000	509,800	500,800	6,600	121,500	-	111,800
22,	273,000	-	217,700	163,000	106,000	175,000	448,400	-	28,900	303,700	112,000	55,500
23,	354,000	129,800	409,300	107,000	-	227,000	449,200	261,300	31,400	18,500	164,000	225,300
24,	-	191,000	175,300	68,000	140,300	181,000	530,200	257,800	35,700	-	58,500	107,000
25,	348,000	173,800	114,000	-	211,000	176,000	-	335,000	43,600	105,700	-	-
26,	134,000	135,000	63,200	228,800	80,000	65,500	227,000	253,300	-	104,500	104,900	-
27,	128,000	181,000	63,000	332,000	122,300	-	173,900	366,800	14,000	105,300	223,000	61,800
28,	273,000	-	-	252,800	143,000	136,000	268,000	-	16,500	93,000	-	59,200
29,	195,000	-	90,000	100,700	107,000	194,500	149,000	-	28,000	16,500	200,500	138,000
30,	238,000	-	132,000	131,700	-	207,500	108,200	169,300	27,100	159,000	43,500	63,800
31,	-	-	194,000	-	-	-	226,200	291,500	-	-	-	102,500
Average,	193,731	204,022	150,277	158,472	184,800	144,976	265,462	284,404	167,056	62,877	104,217	115,404

Average Analyses of Water applied to Filters Nos. 68 and 69.

[Parts per 100,000.]

1897.	Temperature. — Deg. F.	Color.	Ammonia. Free.	Ammonia. Albuminoid. Total.	Ammonia. Albuminoid. Soluble.	Chlorine.	Nitrogen as Nitrates.	Nitrogen as Nitrites.	Oxygen Consumed.	Per Cent. of Dissolved Oxygen.	Bacteria per Cubic Centimeter.
January,	37	.45	.1833	.0547	.0487	.55	.034	.0013	.55	–	193,731
February,	35	.42	.1670	.0450	.0335	.49	.031	.0028	.44	–	204,022
March,	39	.44	.1955	.0505	.0410	.48	.026	.0027	.50	–	150,277
April,	43	.51	.1553	.0447	.0353	.36	.023	.0012	.54	90	158,472
May,	59	.45	.1800	.0490	.0390	.47	.028	.0018	.54	57	184,800
June,	64	.45	.1387	.0533	.0433	.36	.035	.0017	.53	67	144,976
July,	73	.60	.1080	.0500	.0340	.47	.029	.0022	.60	45	265,462
August,	68	.58	.1700	.0525	.0360	.60	.025	.0008	.55	52	284,404
September,	60	.36	.2777	.0259	.0180	.34	.024	.0003	.36	67	167,056
October,	58	.30	.0082	.0206	.0178	.34	.016	.0004	.32	75	62,877
November,	51	.42	.0864	.0291	.0216	.52	.045	.0004	.41	69	104,217
December,	47	.50	.0593	.0223	.0132	.38	.044	.0007	.41	86	115,404
Average,	53	.46	.1441	.0415	.0318	.45	.030	.0014	.48	70	169,641

Filters Nos. 68 and 69.

Filter No. 68 was first put in operation on May 18, 1896, and it has contained during 1897 approximately 45 inches in depth of sand with an effective size of 0.23 millimeter. This filter was operated as a continuous filter during 1897 up to August 25. From that date until the end of the year it was operated as an intermittent filter; that is, its surface remained uncovered four hours daily from August 25 to November 10, and two hours daily from November 11 to December 31; the filter being allowed to drain as thoroughly as it would during the time that the surface was free from water. Referring to the table showing the character of the water applied to this filter, it will be seen that the organic matter in it was considerably greater during the first eight months of the year than during the four remaining months, and the same can be said in regard to the number of bacteria present. The average analyses of the applied water for these two periods are as follows: —

[Parts per 100,000.]

1897.	Color.	Ammonia. Free.	Ammonia. Albuminoid. Total.	Ammonia. Albuminoid. Soluble	Chlorine.	Nitrogen as Nitrates.	Nitrogen as Nitrites.	Oxygen Consumed.	Per Cent. of Dissolved Oxygen.	Bacteria per Cubic Centimeter.
January to August, inclusive,	.47	.1622	.0500	.0388	.47	.029	.0018	.53	62	211,768
September to December, inclusive,	.41	.1151	.0279	.0205	.41	.032	.0006	.40	73	112,388

It will be seen from these averages that during the last four months of the year the water still contained very much more organic matter than the river water, and the bacteria present exceeded 100,000 per cubic centimeter. The average analyses of the effluent of the filter for these two periods are as follows: —

	Rate of Filtration. Gallons per Acre Daily.	Color.	Ammonia. Free.	Ammonia. Albuminoid.	Chlorine.	Nitrogen as Nitrates.	Nitrogen as Nitrites.	Oxygen Consumed.	Per Cent of Dissolved Oxygen.	Bacteria per Cubic Centimeter.
January to August, inclusive,	1,081,875	.41	.1444	.0223	.51	.019	.0002	.37	14	8,049
September to December, inclusive,	1,459,400	.29	.0209	.0119	.43	.072	.0000	.29	69	1,654

These averages show clearly that much better results were obtained when the filter was being operated intermittently, although the rate of filtration was greater by about 370,000 gallons per acre daily during the period of intermittent operation. It will be particularly noticed that, in addition to the better results obtained in regard to the removal of organic matter and bacteria, the percentage of dissolved oxygen was practically the same in the effluent as in the applied water during the second period, while during the period of continuous operation the amount of free oxygen was very much reduced while the water was passing through the filter.

Referring to the bacteria in the water applied to and the effluent from this filter, it will be seen that the numbers present in the effluent were five times as great during the period of continuous operation as they were during the period of intermittent operation, the bacterial efficiency of the filter for the period of continuous operation being 96.2 per cent. For the entire period of intermittent operation the bacterial efficiency of the filter was 98.5, and if we

omit the month of September, when the filter had not reached the state of efficiency which it finally obtained towards the end of the month, it will be seen that the bacterial efficiency of the filter was 99.4 per cent. for the last three months of intermittent filtration.

Receiving the quality of water which it has, and operated at the rates given in the table, the surface of the filter has had to be scraped and approximately 0.3 of an inch of sand removed upon the following dates: January 1, 15, 27, February 12, March 3, 22, April 29 and August 13. Subsequent to this last date, instead of scraping the filter's surface it was raked to the depth of 1 inch at times of clogging, and on the following dates: September 14, November 4, 27 and December 23.

Filter No. 69 was first put in operation on May 18, 1896, and has contained during 1897 approximately 45 inches in depth of sand with an effective size of 0.23 millimeter; that is, it was a duplicate in regard to size and depth of sand of Filter No. 68. It has received during the entire year water of the same quality as that applied to Filter No. 68, but has been operated intermittently instead of continuously. As a result of this method of operation the effluent of the filter has been well purified from a chemical point of view during the entire year, and it has contained as an average 55 per cent. of the amount of oxygen necessary for saturation of the water. The average number of bacteria in the effluent for the year has been 613, giving an average bacterial efficiency of 99.64 per cent.

Operating the filter in the manner described, and at the rate given in the table, it has been necessary to scrape the surface and remove approximately 0.3 of an inch of sand on the following dates: January 1, 12, 19, 27, February 1, 22, March 6, 19, April 2, 23, July 14 and November 4. The surface was raked 1 inch deep on May 10, 20, June 17 and November 26, and 2 inches deep on September 14.

Average Number of Bacteria per Cubic Centimeter in Effluent of Filter No. 68, 1897.

Day of Month.	January.	February.	March.	April.	May.	June.	July.		August.		September.		October.		November.	December.
							Water Bacteria.	B. Prodigiosus.	Water Bacteria.	B. Prodigiosus.	Water Bacteria.	B. Prodigiosus.	Water Bacteria.	B. Prodigiosus.		
1,	1,388	5,750	8,650	3,500	4,400	2,100	9,800	-	-	-	11,800	0	700	0	2,585	303
2,	1,200	17,400	4,700	3,400	-	3,400	6,400	-	3,600	0	9,000	0	100	0	646	344
3,	-	8,750	4,050	4,100	9,750	2,500	9,500	-	5,800	0	4,800	0	-	-	360	210
4,	335	6,250	2,450	-	8,750	2,200	-	-	6,800	0	10,800	0	242	0	106	167
5,	374	9,200	3,100	6,200	19,700	2,800	-	-	26,000	0	-	-	376	2	1,395	-
6,	502	9,800	6,100	-	20,850	-	5,300	-	40,000	0	-	-	256	0	177	188
7,	1,216	-	-	5,250	12,450	1,600	10,000	-	11,000	0	8,500	0	280	3	-	235
8,	636	15,000	2,750	5,650	8,900	2,400	13,100	-	-	-	10,500	0	203	2	-	359
9,	261	11,500	2,550	4,480	-	5,400	11,200	-	8,950	0	1,900	0	65	0	-	258
10,	-	14,000	2,200	11,400	10,650	4,500	15,500	-	9,250	0	11,100	0	-	-	5,400	158
11,	498	13,000	3,950	-	5,950	3,900	-	-	6,200	0	1,400	0	680	0	3,100	126
12,	1,456	-	4,550	6,500	8,350	2,100	17,100	-	7,000	0	-	-	600	1	1,800	-
13,	1,780	11,000	7,600	11,050	14,100	-	19,600	-	-	-	3,300	0	390	1	700	468
14,	1,279	-	-	6,300	6,550	2,000	26,700	-	2,100	0	8,400	0	500	0	-	140
15,	2,280	4,200	22,100	3,700	13,300	2,400	-	-	-	-	4,500	0	330	2	530	193
16,	4,080	4,450	42,200	3,800	-	7,400	-	-	2,400	0	3,500	0	74	0	195	117
17,	-	1,900	5,000	6,800	5,550	9,200	-	-	6,700	0	3,800	0	-	-	250	99
18,	3,185	3,150	5,000	-	4,300	3,000	-	-	9,900	0	1,700	0	7,440	0	287	118
19,	7,107	7,550	10,900	-	4,650	3,200	11,600	0	8,650	0	-	-	1,880	0	147	-
20,	1,880	7,100	-	7,150	7,800	-	3,500	0	12,200	0	1,500	0	2,540	0	226	234
21,	1,974	-	-	5,100	8,750	9,200	4,700	100	19,400	100	1,200	0	1,537	0	-	133
22,	4,028	-	-	94,000	4,300	8,000	7,000	100	-	-	5,900	0	1,170	0	346	121
23,	14,472	5,700	800	3,450	-	8,800	12,000	0	6,800	0	1,800	0	201	0	104	1,420
24,	-	4,950	4,000	9,300	4,350	5,900	31,000	0	11,400	0	1,000	0	-	-	276	302
25,	6,584	7,000	3,300	-	3,700	6,100	-	-	10,100	0	900	0	757	0	-	-
26,	4,889	6,500	2,300	5,100	6,800	7,400	23,000	0	15,700	0	-	-	1,050	0	142	-
27,	11,000	3,800	2,100	7,950	3,900	-	8,200	0	26,100	0	2,000	0	231	0	219	216
28,	3,700	-	-	9,400	1,700	8,400	14,000	0	5,700	0	2,000	0	165	0	-	111
29,	9,000	-	2,000	-	3,800	9,200	5,100	0	-	-	2,100	0	64	2	1,472	112
30,	3,699	-	3,900	6,750	-	4,200	4,600	0	13,000	0	1,900	0	134	0	222	338
31,	-	-	2,600	-	-	-	5,300	0	14,500	0	-	-	-	-	-	290
Average,	3,415	8,089	6,354	10,014	8,132	4,896	11,922	-	11,570	-	4,612	-	845	-	899	260

Effluent of Filter No. 68.

[Parts per 100,000.]

1897.	Quantity of Effluent. — Gallons per Acre Daily.	Temperature. Deg F.		Color.	Ammonia.		Chlorine.	Nitrogen as		Oxygen Consumed.	Per Cent. of Dissolved Oxygen.	Bacteria per Cubic Centimeter.
		Applied Water.	Effluent.		Free.	Albuminoid.		Nitrates.	Nitrites.			
January, . .	991,000	37	44	.38	.1700	.0200	.60	.010	.0003	.40	8	3,415
February, .	1,090,000	35	49	.48	.1875	.0254	.61	.006	.0000	.33	9	8,089
March, . .	1,080,000	39	50	.30	.1405	.0195	.52	.018	.0002	.31	20	6,354
April, . .	1,092,000	43	51	.41	.1567	.0293	.38	.030	.0004	.33	18	10,014
May, . . .	1,091,000	59	59	.39	.1900	.0330	.39	.007	.0000	.40	12	8,132
June, . .	1,110,000	64	60	.38	.1165	.0192	.46	.031	.0001	.37	18	4,896
July, . . .	1,054,000	73	71	.48	.1165	.0172	.49	.015	.0003	.41	9	11,922
August, . .	1,147,000	68	71	.46	.0774	.0152	.66	.037	.0002	.39	22	11,570
September, .	1,248,000	60	61	.27	.0019	.0121	.38	.064	.0000	.28	78	4,612
October, . .	1,394,000	58	59	.22	.0007	.0094	.37	.040	.0000	.24	89	845
November, .	1,628,000	51	53	.28	.0038	.0117	.51	.110	.0001	.28	67	899
December, .	1,800,000	47	54	.32	.0012	.0080	.40	.108	.0000	.30	74	260
Average, .	1,227,000	53	57	.36	.0969	.0183	.48	.040	.0001	.34	35	8,049

Average Number of Bacteria per Cubic Centimeter in Effluent of Filter No. 69, 1897.

Day of Month.	January.	February.	March.	April.	May.	June.	July.		August.		September.		October.		November.	December.
							Water Bacteria.	B. Prodigiosus.	Water Bacteria.	B. Prodigiosus.	Water Bacteria.	B. Prodigiosus.	Water Bacteria.	B. Prodigiosus.		
1,	526	113	640	159	134	883	373	-	-	-	810	0	101	0	370	130
2,	348	864	796	-	-	110	111	-	600	0	245	0	147	1	150	257
3,	-	308	499	93	84	206	350	-	856	0	760	0	-	-	75	215
4,	299	436	247	-	458	295	-	-	205	0	787	0	376	2	51	148
5,	123	378	216	2,973	314	178	-	-	120	0	-	-	416	1	346	-
6,	95	620	76	2,363	207	-	303	-	283	0	-	-	240	0	81	102
7,	150	-	-	299	159	560	271	-	108	0	330	0	266	0	-	75
8,	127	231	610	535	187	473	144	-	-	-	2,384	0	103	0	-	57
9,	160	7,040	394	627	-	454	145	-	544	0	3,200	0	640	0	-	133
10,	-	517	266	432	-	342	122	-	1,520	0	760	0	-	-	3,100	141
11,	129	7,504	441	-	4,553	282	-	-	434	0	720	0	370	0	1,000	99
12,	211	1,059	294	514	6,896	145	347	-	261	0	-	-	704	0	3,200	-
13,	461	336	304	1,084	1,166	-	880	-	425	0	172	0	653	0	2,100	223
14,	566	-	-	306	3,650	92	212	-	134	0	1,336	0	188	0	-	98
15,	113	708	162	124	300	138	-	-	-	-	2,616	0	583	0	440	148
16,	75	360	-	117	-	117	-	-	587	0	600	0	444	0	229	101
17,	-	313	433	119	218	122	-	-	1,672	0	370	0	-	-	168	114
18,	67	155	141	-	97	537	-	-	640	0	306	0	920	0	370	64
19,	686	132	-	-	197	944	1,276	-	784	0	-	-	1,015	0	199	-
20,	2,688	81	95	140	174	-	583	0	566	0	370	0	713	0	244	331
21,	758	-	-	832	670	1,294	799	0	416	0	128	0	1,453	0	-	64
22,	133	-	329	378	1,552	5,106	1,088	0	-	-	306	0	720	0	168	63
23,	38	252	529	211	-	920	581	0	1,735	0	153	0	236	0	127	68
24,	-	1,512	71	164	98	852	1,004	0	2,273	0	396	0	-	-	84	92
25,	2,509	1,672	66	-	145	459	-	-	425	1	200	0	400	0	-	-
26,	1,185	1,116	101	716	123	1,224	144	0	477	0	-	-	670	0	177	-
27,	768	744	65	697	124	-	1,112	0	888	0	200	0	49	0	944	83
28,	1,456	-	-	673	110	980	1,000	0	189	0	296	0	82	0	-	97
29,	812	-	159	992	120	1,524	160	0	-	-	638	0	255	0	800	44
30,	198	-	87	445	-	330	353	0	155	0	175	0	125	0	204	55
31,	-	-	144	-	-	-	896	0	88	0	-	-	-	-	-	121
Average,	565	1,150	287	625	906	714	533	-	630	-	730	-	456	-	636	120

Effluent of Filter No 69.

[Parts per 100,000.]

1897.	Quantity of Effluent. — Gallons per Acre Daily.	Temperature. Deg. F.		Color.	Ammonia.		Chlorine.	Nitrogen as		Oxygen Consumed.	Per Cent. of Dissolved Oxygen.	Bacteria per Cubic Centimeter.
		Applied Water.	Effluent.		Free.	Albuminoid.		Nitrates.	Nitrites.			
January, . .	1,131,000	37	41	.29	.0055	.0099	.60	.192	.0001	.29	63	565
February, .	1,237,000	35	49	.35	.0108	.0119	.46	.141	.0000	.26	46	1,150
March, . .	1,234,000	39	49	.26	.0022	.0104	.50	.123	.0000	.24	62	287
April, . .	1,236,000	43	51	.34	.0161	.0106	.37	.141	.0000	.29	63	625
May, . . .	1,254,000	59	60	.44	.0035	.0160	.44	.082	.0000	.42	32	906
June, . .	1,201,000	64	61	.36	.0009	.0104	.41	.103	.0000	.33	43	714
July, . . .	1,129,000	73	71	.32	.0040	.0094	.47	.131	.0002	.33	31	533
August, . .	1,207,000	68	71	.29	.0009	.0089	.72	.200	.0000	.28	49	630
September, .	1,230,000	60	61	.20	.0009	.0095	.37	.077	.0000	.24	63	730
October, . .	1,373,000	58	58	.19	.0007	.0079	.37	.039	.0000	.22	87	456
November, .	1,868,000	51	52	.21	.0023	.0102	.52	.121	.0000	.25	61	636
December, .	1,880,000	47	52	.28	.0009	.0067	.40	.109	.0000	.26	61	120
Average, .	1,332,000	53	56	.29	.0041	.0102	.47	.122	.0000	.28	55	613

Filtration of the Effluents of Filters Nos. 68 and 69.

The effluents of these two filters have been applied to a third filter, Filter No. 79. This filter contains 4 feet in depth of sand of an effective size of 0.23 millimeter, and the average rate of filtration for the year has been 4,091,000 gallons per acre daily. The bacterial results obtained during 1897 have not been entirely satisfactory, but exceedingly interesting. The water applied, having already passed through the sand filters Nos. 68 and 69, has had removed from it the organic matter essential in coating the sand grains of a filter to a certain depth, in order that good bacterial efficiency may be obtained.

The following tables give the average chemical analyses of the effluent, and the average daily number of bacteria in the water applied to and the effluent from this filter. In studying the table showing the number of bacteria in the applied water, which, as has been stated, was the combined effluent of Filters Nos. 68 and 69, it will be noticed that the average daily number is much greater than shown by the tables giving the average daily numbers of bacteria in the effluents of the two filters. The reason of this was that, before being applied to the third filter, the effluents were stored for a period of several hours each day during a portion of the year in a wooden tank, and during the remainder in a galvanized-iron tank. On account

of this storage there was a very marked growth of bacteria in the filtered water. The reason of this growth is not entirely understood, but a large number of experiments have been made to determine the cause.

Growth of Bacteria in Filtered Water.

The effluent from the Lawrence city filter, when pumped into the reservoir, contains a certain small number of bacteria, and samples taken from the reservoir show at most only a slight increase of numbers as compared with the number present when the water enters the reservoir; that is, when filtered water is stored in a large body, the numbers of bacteria decrease rather than increase. When the filtered water from our two small filters, however, was stored in a tank which would hold only about 70 gallons, there was a very great increase in the numbers of bacteria. It was thought that the reason of this increase was not by a growth in the water itself, but by a growth along the sides and bottom of the tank amongst the bacteria which became attached to the sides and bottom, and experiments were made to determine whether this theory was true or not. For this purpose a series of bottles of different sizes, varying from a half-pint bottle to a carboy holding 12 gallons, were filled on a number of different occasions with filtered water, the numbers of bacteria present when the bottles were filled being ascertained, and daily samples being collected from each bottle, and the numbers of bacteria present determined. While these experiments were in some respects contradictory, yet generally the bottles having the greatest side area, compared with the volume of water contained, showed the greatest increase day by day in the numbers of bacteria present. Even though in some instances the number of bacteria present in the larger bottles after several days' growth equalled the number present in the water contained in the smaller ones, it must be remembered that all the bottles used in these experiments held a very small volume of water as compared with the volume in a reservoir; and besides, there was practically no decrease on account of sedimentation, as may be the case in the city reservoir. The bacteria in these bottles of filtered water grew as well with the bottles in the dark as when they were exposed to the light. Notwithstanding this growth in the storage tank the filter gave an average bacterial efficiency for the year of 96.34 per cent. During December the effluents were applied to Filter No. 90, a filter containing a less depth of sand than Filter

No. 79, but which had received river water and hence had a coating upon its sand grains. This filter removed a greater percentage of the bacteria (see page 476).

Average Daily Number of Bacteria per Cubic Centimeter in Water applied to Filter No. 79.

Day.	January.	February.	March.	April.	May.	June.	July.	August.	September.
1, ...	1,088	5,000	6,800	4,000	11,200	5,800	21,500	-	4,400
2, ...	1,276	7,800	6,600	4,000	-	5,000	7,500	68,400	20,300
3, ...	-	4,000	6,400	12,400	4,000	4,900	11,900	11,500	9,800
4, ...	-	6,700	7,500	-	9,200	4,000	-	18,500	17,800
5, ...	-	6,300	9,500	17,100	16,200	4,800	-	17,900	-
6, ...	2,100	2,500	9,700	8,100	26,500	-	3,300	18,400	-
7, ...	1,136	-	-	8,600	12,900	10,600	11,500	27,500	7,500
8, ...	992	14,000	9,160	4,300	31,200	7,000	14,000	-	14,100
9, ...	810	13,000	3,800	9,500	-	11,100	26,600	11,900	9,900
10, ...	-	-	4,400	9,850	13,900	4,800	-	25,400	7,100
11, ...	1,425	13,000	4,100	-	8,100	8,800	-	6,200	11,200
12, ...	504	13,500	6,800	23,950	-	4,300	18,100	5,800	-
13, ...	2,488	3,800	6,500	6,050	22,500	-	24,400	6,200	6,000
14, ...	2,025	-	-	4,600	10,900	3,100	24,500	8,100	3,900
15, ...	-	-	8,300	36,900	15,300	5,500	-	-	7,400
16, ...	4,580	-	6,400	-	-	5,600	-	3,900	8,300
17, ...	-	-	6,600	2,000	8,700	8,800	-	4,800	3,000
18, ...	-	-	6,700	-	8,600	11,900	-	10,600	7,300
19, ...	5,588	-	6,700	-	3,500	11,000	-	9,800	-
20, ...	16,896	-	11,100	10,250	6,700	-	9,300	-	3,300
21, ...	4,068	-	-	7,600	10,200	18,100	8,900	35,000	8,500
22, ...	4,900	-	8,700	6,400	-	12,400	10,600	-	4,200
23, ...	3,724	9,500	4,100	6,300	-	8,200	16,100	15,900	3,200
24, ...	-	8,300	3,600	7,800	5,000	5,300	24,500	20,600	2,300
25, ...	6,846	6,100	2,700	-	8,900	6,000	-	18,600	2,100
26, ...	3,936	5,200	1,500	4,600	11,600	8,900	6,200	8,500	-
27, ...	5,300	8,800	2,800	-	16,100	-	9,500	-	2,000
28, ...	8,200	-	-	16,150	3,500	21,800	-	11,700	2,800
29, ...	5,500	-	15,400	38,700	16,300	21,600	6,800	-	5,600
30, ...	8,000	-	4,800	8,500	-	4,900	7,500	18,500	7,800
31, ...	-	-	5,000	-	-	-	18,300	10,900	-
Average, ...	4,154	7,969	6,506	11,202	12,217	8,623	14,050	16,442	7,192

Average Daily Number of Bacteria per Cubic Centimeter in Effluent of Filter No. 79.

Day.	January.	February.	March.	April.	May.	June.	July.	August.	September.
1,	209	124	700	127	245	73	416	-	110
2,	207	107	500	97	-	370	116	672	350
3,	-	128	200	132	84	386	181	75	319
4,	-	138	200	-	108	306	-	145	615
5,	-	93	100	51	123	227	-	45	-
6,	191	123	300	164	188	-	354	306	-
7,	167	-	-	93	111	2,024	388	910	294
8,	163	184	47	250	133	84	101	-	365
9,	111	183	76	116	-	104	103	1,880	235
10,	-	-	70	95	163	460	-	99	351
11,	106	520	113	-	144	450	-	624	368
12,	104	376	165	324	-	396	302	65	-
13,	159	116	210	271	768	-	346	600	247
14,	100	-	-	234	578	176	680	98	281
15,	-	-	167	200	388	181	-	-	270
16,	100	-	167	-	-	255	-	1,752	632
17,	-	-	152	115	776	624	-	195	476
18,	-	-	134	-	1,083	188	-	-	672
19,	465	-	102	-	-	235	-	470	-
20,	191	-	129	155	370	-	840	-	680
21,	442	-	-	243	93	2,064	212	896	435
22,	982	-	109	119	-	211	74	-	379
23,	438	-	81	112	-	324	153	1,782	171
24,	-	1,700	264	142	76	664	388	864	537
25,	728	1,100	127	-	81	283	-	330	-
26,	526	1,100	81	72	73	240	365	84	-
27,	384	1,100	107	-	82	-	218	-	101
28,	370	-	-	688	167	253	-	832	575
29,	174	-	115	220	83	776	752	-	918
30,	192	-	87	165	-	744	330	269	146
31,	-	-	100	-	-	-	200	488	-
Averages,	296	473	190	182	269	465	325	586	397

Effluent of Filter No. 79.

[Parts per 100,000.]

1897.	Quantity of Effluent. — Gallons per Acre Daily.	Temperature. Deg. F.		Color.	Ammonia.		Chlorine.	Nitrogen as		Oxygen Consumed.	Per Cent. of Dissolved Oxygen.	Bacteria per Cubic Centimeter.
		Applied Water.	Effluent.		Free.	Albuminoid.		Nitrates.	Nitrites.			
January,	4,268,000	43	44	.29	.0058	.0115	.60	.153	.0001	.28	57	296
February,	4,202,000	49	48	.33	.0040	.0128	.28	.033	.0000	.35	53	473
March,	4,742,000	50	51	.26	.0022	.0108	.43	.111	.0000	.26	61	190
April,	4,610,000	51	52	.27	.0018	.0107	.39	.144	.0000	.29	44	182
May,	4,363,000	60	59	.31	.0022	.0129	.40	.130	.0002	.34	32	269
June,	3,951,000	61	60	.35	.0012	.0095	.43	.107	.0007	.34	54	465
July,	4,115,000	71	71	.33	.0020	.0102	.44	.094	.0000	.31	32	325
August,	3,905,000	71	69	.30	.0011	.0097	.79	.164	.0000	.31	50	586
September,	2,660,000	61	60	.20	.0010	.0101	.43	.120	.0000	.25	91	397
Average,	4,091,000	57	57	.29	.0024	.0109	.47	.117	.0001	.30	53	354

Filter No. 18 A.

This intermittent filter is 20 inches in diameter, was first in operation in 1889 and has been operated a portion of each year since that date. It contains sand of an effective size of 0.48 millimeter, and during 1897 the depth of sand has been approximately 60 inches. It was kept in operation during 1897 from May 28 to September 2 inclusive. Merrimack River water was applied to it, and the average rate of filtration maintained during this period was 4,651,000 gallons per acre daily. Tables showing the results obtained follow. It was not necessary to scrape the filter during this period of operation.

Average Daily Number of Bacteria per Cubic Centimeter in Effluent of Filter No. 18 A, 1897.

Day of Month.	May.	June.	July.	August.
1,	-	131	43	-
2,	-	74	92	123
3,	-	53	94	37
4,	-	63	-	54
5,	-	221	-	88
6,	-	-	197	94
7,	-	215	39	55
8,	-	194	48	-

Average Daily Number of Bacteria per Cubic Centimeter in Effluent of Filter No. 18 A, 1897 — Concluded.

Day of Month.	May.	June.	July.	August.
9,	–	183	13	97
10,	–	173	94	102
11,	–	98	–	30
12,	–	206	91	85
13,	–	–	98	48
14,	–	61	99	39
15,	–	35	–	–
16,	–	42	–	112
17,	–	74	–	30
18,	–	32	–	52
19,	38,600	73	41	83
20,	12,500	–	152	37
21,	1,900	203	153	108
22,	198	89	94	–
23,	–	45	55	102
24,	116	46	108	91
25,	53	31	–	54
26,	126	41	177	22
27,	272	–	53	80
28,	508	376	39	74
29,	90	85	30	–
30,	–	37	122	98
31,	–	–	29	45
Average,	–	111	81	71

Effluent of Filter No. 18 A.

[Parts per 100,000.]

1897.	Quantity of Effluent. — Gallons per Acre Daily.	Temperature. Deg. F.		Color.	Ammonia.		Chlorine.	Nitrogen as		Oxygen Consumed.	Per Cent. of Dissolved Oxygen.	Bacteria per Cubic Centimeter.
		Applied Water.	Effluent.		Free.	Albuminoid.		Nitrates.	Nitrites.			
May,	4,825,000	59	60	.34	.0016	.0126	.14	.024	.0000	.38	65	–
June,	4,713,000	64	61	.37	.0009	.0087	.11	.024	.0000	.39	74	111
July,	4,488,000	73	73	.42	.0018	.0111	.13	.021	.0000	.44	71	81
August,	4,578,000	68	70	.36	.0012	.0100	.18	.025	.0000	.31	69	71
Average,	4,651,000	66	66	.37	.0014	.0106	.14	.024	.0000	.38	70	88

Filter No. 33 A.

This continuous filter, 20 inches in diameter, was first put into operation during 1892 and has been operated a portion of each year since that date. It contains sand with an effective size of 0.14 millimeter, and during 1897 the depth of sand has been approximately 36 inches. It was kept in operation during 1897 from April 30 to August 27, inclusive. Merrimack River water was applied and the average rate of filtration maintained was 2,037,000 gallons per acre daily. The filter was scraped but once during this period of operation, on July 31. The tables showing the results obtained follow : —

Average Daily Number of Bacteria per Cubic Centimeter in Effluent of Filter No. 33 A, 1897.

Day.	May.	June.	July.	August.
1,	-	28	100	-
2,	-	41	13	24
3,	-	54	62	21
4,	2,500	41	-	7
5,	15,000	38	-	45
6,	2,000	-	187	33
7,	6,000	23	127	112
8,	-	8	52	-
9,	-	21	27	87
10,	4,000	48	25	4
11,	172	46	-	43
12,	30	76	311	27
13,	33	-	121	112
14,	19	24	212	16
15,	80	22	-	-
16,	-	45	-	88
17,	65	62	-	29
18,	38	28	-	48
19,	36	20	37	138
20,	51	-	29	178
21,	40	90	36	233
22,	45	118	12	-
23,	-	93	106	243
24,	44	27	36	-
25,	83	17	-	-

Average Daily Number of Bacteria per Cubic Centimeter in Effluent of Filter No. 33 A, 1897 — Concluded.

Day.	May.	June.	July.	August.
26,	69	93	47	-
27,	30	-	65	-
28,	90	172	33	-
29,	31	112	3	-
30,	-	55	36	-
31,	-	-	27	-
Average,	-	54	74	78

Effluent of Filter No. 33 A.

[Parts per 100,000.]

1897.	Quantity of Effluent. — Gallons per Acre Daily.	Temperature. Deg. F.		Color.	Ammonia.		Chlorine.	Nitrogen as		Oxygen Consumed.	Per Cent. of Dissolved Oxygen	Bacteria per Cubic Centimeter.
		Applied Water.	Effluent.		Free.	Albuminoid.		Nitrates.	Nitrites.			
May,	1,832,000	59	61	.32	.0020	.0096	.14	.027	.0000	.34	63	-
June,	1,884,000	64	62	.36	.0013	.0077	.11	.023	.0000	.37	54	54
July,	2,536,000	73	73	.41	.0037	.0123	.11	.018	.0001	.44	23	74
August,	1,896,000	68	72	.35	.0011	.0099	.18	.018	.0000	.31	18	78
Average,	2,037,000	66	67	.36	.0020	.0099	.14	.022	.0000	.37	40	69

Filtration through Ashes, Filter No. 86.

Filter No. 86 was first put into operation on May 28, 1897, and contained 48 inches in depth of coal ashes. Merrimack River water was applied to it at an average rate of 4,206,000 gallons per acre daily. The effluent of the filter has been clear and odorless, and the removal of organic matter from the applied water has been equal to the removal obtained by the best of our sand filters. The effluent is slightly harder than the river water. The bacterial efficiency of the filter, however, has not been equal to that obtained by sand filters. The surface of the filter did not become clogged during its period of operation. The tables showing the chemical and bacterial results obtained follow: —

Average Daily Number of Bacteria per Cubic Centimeter in Effluent of Filter No. 86, 1897.

Day of Month.	May.	June.	July. Water Bacteria.	July. B. Prodigiosus.	August. Water Bacteria	August. B. Prodigiosus.	September. Water Bacteria.	September. B. Prodigiosus.
1,	–	73,500	330	–	–	–	113	1
2,	–	139,800	297	–	69	0	114	0
3,	–	183,300	384	–	74	0	154	1
4,	–	92,600	–	–	105	0	143	1
5,	–	27,000	–	–	90	0	–	–
6,	–	–	553	–	294	0	–	–
7,	–	207,600	301	–	159	0	276	0
8,	–	49,600	325	–	–	–	342	0
9,	–	10,200	124	–	218	0	573	0
10,	–	12,200	143	–	54	0	1,116	0
11,	–	13,200	–	–	117	0	370	0
12,	–	20,200	672	–	109	0	–	–
13,	–	–	104	–	101	0	303	0
14,	–	4,200	224	–	38	0	259	0
15,	–	5,200	–	–	–	–	832	0
16,	–	4,300	–	–	445	0	531	2
17,	–	3,000	–	–	144	1	441	1
18,	–	2,400	–	–	146	1	214	2
19,	–	8,100	200	–	71	1	–	–
20,	–	–	189	0	142	4	177	3
21,	–	11,100	82	0	106	2	116	1
22,	–	2,600	132	1	–	–	612	12
23,	–	1,700	207	0	750	2	235	5
24,	–	1,700	167	0	154	0	190	3
25,	–	500	–	–	283	1	171	2
26,	–	1,500	128	2	140	1	–	–
27,	–	–	128	0	174	2	233	4
28,	61,900	7,300	113	0	138	2	166	2
29,	104,400	700	128	0	–	–	568	0
30,	–	507	148	0	820	4	286	0
31,	–	–	110	0	120	3	–	–

Effluent of Filter No. 86.

[Parts per 100,000.]

1897.	Quantity of Effluent. — Gallons per Acre Daily.	Temperature. Deg. F.		Color.	Ammonia.		Chlorine.	Nitrogen as		Oxygen Consumed.	Per Cent. of Dissolved Oxygen.	Bacteria per Cubic Centimeter.
		Applied Water.	Effluent.		Free.	Albuminoid.		Nitrates.	Nitrites.			
June,	4,822,000	64	62	.37	.0061	.0129	.13	.012	.0021	.38	41	-
July,	4,574,000	73	73	.41	.0026	.0120	.14	.015	.0000	.43	27	224
August,	4,545,000	68	71	.36	.0009	.0098	.18	.025	.0000	.31	29	194
September,	2,791,000	60	63	.24	.0006	.0084	.28	.026	.0000	.25	21	341
Average,	4,206,000	66	67	.35	.0026	.0108	.18	.020	.0005	.34	30	-

Lawrence City Filter.

The filter of the water-supply system of the city of Lawrence is 2.5 acres in area, was first put into operation Sept. 20, 1893, and its construction and action were described in the report of the State Board of Health for that year. From the date of starting this filter up to the present time it has been in continuous use, and not once has the unfiltered river water entered the reservoir or the service pipes of the city water supply.

During the winter of 1896–97 daily bacterial analyses were made of samples of the river water collected at the pumping station and the filtered water collected at different parts of the system. The results up to May 1 were presented in the annual report of the Board for 1896. From this date until November 1 the analyses were made once each week. Beginning November 1 daily bacterial examinations were begun and continued until May 1, 1898. The results of these examinations are given in tables beyond.

B. Coli Communis.

In addition to determining the total number of bacteria per cubic centimeter in the effluent of the filter, determinations of the presence or absence of *B. coli communis*, the characteristic organism of sewage, have been made in 400 samples collected at the pumping station just as the water is pumped from the filter to the reservoir. This

germ is always present in large numbers in the river water. On only six occasions, however, has its presence been detected in the effluent of the filter, and on several of these days the reason of its presence was apparent on account of deep scraping or because pumping tests with a new pump were being made, and water pumped was being allowed to run back over the floor of the pumping station into the filter well.

The following table gives the typhoid fever death-rate of the city for six years previous to the construction of the filter, for the year of its construction when filtered water was used for three months, and for the following years.

In connection with this table it must be stated that supplies of water pumped directly from the canals are used for some purposes in the mills and this water is used to some extent by the operatives in these mills.

Deaths from Typhoid Fever in Lawrence, 1887–97.

Years.	Total Number of Deaths.	Deaths per 10,000 of Population.	Persons who may have been exposed to Infection — By drinking Canal Water.	Persons who may have been exposed to Infection — While Living out of Town just before falling Sick in Lawrence.
1887,	47	11.44	-	-
1888,	48	11.36	-	-
1889,	55	12.66	-	-
1890,	60	13.44	-	-
1891,	55	11.94	-	-
1892,	50	10.52	-	-
1893,	39	7.96	-	-
1894,	24	4.75	12	4
1895,	16	3.07	9	2
1896,	10	1.86	2	4
1897,	9	1.62	-	-

Bacteria per Cubic Centimeter in River and Filtered Water.

[Weekly examinations, May to October inclusive.]

Week ending —	Merrimack River Water.	Filtered Water from			
		City Filter.	Reservoir Outlet.	Tap at City Hall.	Tap at Experiment Station.
May 8,	5,000	36	52	42	42
15,	5,600	35	25	43	34
22,	3,200	40	68	29	25
29,	4,700	28	86	189	83
June 5,	4,300	31	85	115	65
12,	7,100	114*	85	57	51
19,	3,800	40	95	50	50
26,	3,400	43	105†	102	45
July 3,	6,300	110	376	428	161
10,	6,000	88	352	356	148
17,	8,800	210‡	616	372	172
24,	4,800	68	265	100	75
31,	5,300	35	440	265	66
Aug. 7,	6,400	34	47	60	32
14,	4,600	22	83	75	48
21,	2,800	9	119	89	47
28,	29,000	229§	143	108	45
Sept. 4,	11,700	82	86	73	67
11,	67,000	58	104	40	69
18,	8,300	178‖	152	100	74
25,	22,300	75	102	103	71
Oct. 2,	13,500	37	74	105	39
9,	9,500	35	39	37	26
16,	10,500	12	41	86	67
23,	22,400	14	110	100	97
30,	10,300	69	84	65	74
Averages,	11,000	67	148	123	68

* Tests on Barr high-pressure pump; water taken from low-service pump, which was run at full speed, fed into Barr pump, and run thence on floor of pumping station back into pump well.

† Masses of algæ noted floating in reservoir, and shortly after this *B. Ramosus* became common in samples from reservoir, city hall and laboratory tap.

‡ July 15-16, high water in river; after it subsided the whole of filter was scraped in one day.

§ Large number of bacteria in river water; also a large portion of filter scraped, forked and sanded shortly before.

‖ Sample collected at 12 o'clock midnight and allowed to stand in engine room till 9 o'clock next morning.

Daily Bacterial Results, Lawrence City Water.

[Bacteria per Cubic Centimeter.]

DATE — 1897.	In River Water.	In Filtered Water from				Condition of Surface when Pumps were Stopped.
		City Filter.	Reservoir Outlet.	Tap at City Hall.	Tap at Experiment Station.	
November 1,	4,800	16	38	31	37	Covered.
2,	10,900	14	-	37	45	Covered.
3,	5,000	14	-	71	41	Drained.
4,	9,700	37	-	62	38	Drained.
5,	10,900	31	-	54	57	Covered.
6,	7,300	19	-	47	76	Covered.
7,	-	-	-	-	-	-
8,	5,800	14	45	47	40	Covered.
9,	7,700	94	-	54	37	Covered.
10,	3,500	23	-	38	41	Drained.
11,	5,300	34	-	100	41	Drained.
12,	10,500	5	-	52	44	Covered.
13,	8,100	21	-	38	34	Covered.
14,	-	-	-	-	-	-
15,	7,300	16	-	41	34	Covered.
16,	5,500	16	-	23	50	Covered.
17,	6,300	13	44	48	18	Drained.
18,	6,500	93	-	33	44	Drained.
19,	6,700	21	-	37	75	Covered.
20,	5,300	18	-	38	44	Covered.
21,	-	-	-	-	-	-
22,	6,700	27	24	65	29	Drained.
23,	3,900	20	-	35	30	Drained.
24,	7,300	18	-	25	38	Covered.
25,	-	-	-	-	-	-
26,	6,500	20	-	33	25	Covered.
27,	5,600	20	-	27	24	Drained.
28,	-	-	-	-	-	-
29,	5,900	59	24	31	15	Covered.
30,	3,100	10	-	15	8	Covered.
Averages,	6,644	27	35	43	38	-

Daily Bacterial Results, Lawrence City Water.

[Bacteria per Cubic Centimeter.]

Date — 1897.	In River Water.	In Filtered Water from				Condition of Surface when Pumps were Stopped.
		City Filter.	Reservoir Outlet.	Tap at City Hall.	Tap at Experiment Station.	
December 1,	4,800	16	-	25	31	Drained.
2,	4,500	33	-	36	23	Drained.
3,	4,500	21	-	27	15	Covered.
4,	4,500	38	-	21	22	Covered.
5,	-	-	-	-	-	-
6,	5,100	19	24	20	24	Covered.
7,	8,000	9	-	24	17	Covered.
8,	5,300	19	-	16	30	Covered.
9,	2,800	25	-	67	10	Covered.
10,	7,700	9	-	29	21	Covered.
11,	7,200	22	-	35	30	Drained.
12,	-	-	-	-	-	-
13,	8,000	13	24	29	41	Drained.
14,	5,300	25	-	22	26	Drained.
15,	6,900	16	-	46	21	Covered.
16,	9,600	42	-	14	23	Covered.
17,	7,800	3	-	16	20	Covered.
18,	4,800	42	-	32	7	Covered.
19,	-	-	-	-	-	-
20,	9,200	6	40	26	22	Covered.
21,	3,700	35	-	20	43	Covered.
22,	3,500	17	-	14	47	Covered.
23,	2,400	12	-	19	15	Covered.
24,	3,500	15	-	35	32	Covered.
25,	-	-	-	-	-	-
26,	-	-	-	-	-	-
27,	6,500	71	20	15	20	Covered.
28,	5,000	24	-	23	23	Covered.
29,	7,600	36	-	50	36	Drained.
30,	4,400	45	-	25	34	Covered.
31,	2,500	7	-	3	24	Drained.
Averages,	5,581	24	27	26	25	-

Daily Bacterial Results, Lawrence City Water.

[Bacteria per Cubic Centimeter.]

Date — 1898.	In River Water.	In Filtered Water from				Condition of Surface when Pumps were Stopped.
		City Filter.	Reservoir Outlet.	Tap at City Hall.	Tap at Experiment Station.	
January 1,	8,900	45	-	22	37	Covered.
2,	-	-	-	-	-	-
3,	7,200	113	32	32	27	Covered.
4,	8,700	125	-	33	33	Covered.
5,	15,100	106	-	50	35	Drained.
6,	6,100	43	-	47	48	Covered.
7,	2,300	22	-	21	31	Drained.
8,	7,300	19	-	18	10	Covered.
9,	-	-	-	-	-	-
10,	6,000	27	69	76	28	Covered.
11,	4,400	19	-	41	22	Drained.
12,	6,100	12	-	50	27	Covered.
13,	4,400	22	-	47	26	Drained.
14,	5,100	22	-	22	25	Covered.
15,	6,800	56	-	17	56	Drained.
16,	-	-	-	-	-	-
17,	26,600	8	63	10	15	Covered.
18,	4,400	14	-	14	34	Covered.
19,	2,700	10	-	12	15	Covered.
20,	2,800	19	-	28	15	Covered.
21,	7,100	15	-	8	14	Covered.
22,	6,700	58	-	27	21	Covered.
23,	-	-	-	-	-	-
24,	3,300	22	-	43	39	Covered.
25,	3,200	38	34	35	34	Covered.
26,	4,900	66	-	56	44	Covered.
27,	4,100	24	-	57	43	Covered.
28,	4,400	42	-	67	48	Covered.
29,	3,600	28	-	43	54	Covered.
30,	-	-	-	-	-	-
31,	7,300	40	34	15	79	Covered.
Averages,	6,519	39	46	34	33	-

Daily Bacterial Results, Lawrence City Water.

[Bacteria per Cubic Centimeter.]

Date – 1898.	In River Water.	In Filtered Water from				Condition of Surface when Pumps were Stopped.
		City Filter.	Reservoir Outlet.	Tap at City Hall	Tap at Experiment Station.	
February 1,	-	-	-	-	71	Covered.
2,	-	-	-	42	35	Covered.
3,	4,500	42	-	-	2	Covered.
4,	-	-	-	-	31	Covered.
5,	8,300	16	-	18	36	Covered.
6,	-	-	-	-	-	-
7,	6,100	40	45	24	70	Covered.
8,	4,000	32	-	18	26	Covered.
9,	3,500	25	-	-	15	Covered.
10,	5,700	37	-	12	10	Covered.
11,	-	-	-	76	43	Covered.
12,	5,300	31	-	18	53	Drained.
13,	-	-	-	-	-	-
14,	4,000	51	55	28	24	Covered.
15,	-	-	-	-	23	Covered.
16,	3,500	50	-	16	18	Drained.
17,	-	-	-	-	11	Covered.
18,	3,000	51	-	30	29	Covered.
19,	10,600	36	-	14	8	Drained.
20,	-	-	-	-	-	-
21,	2,500	57	35	23	16	Covered.
22,	-	-	-	-	-	Covered.
23,	4,900	69	-	20	36	Covered.
24,	2,700	106	-	42	22	Covered.
25,	4,900	77	-	38	7	Covered.
26,	2,700	34	-	24	21	Drained.
27,	-	-	-	-	-	-
28,	2,900	17	22	34	18	Covered.
Averages,	4,653	45	39	28	27	-

Daily Bacterial Results, Lawrence City Water.

[Bacteria per Cubic Centimeter.]

Date — 1898.	In River Water.	In Filtered Water from				Condition of Surface when Pumps were Stopped.
		City Filter.	Reservoir Outlet.	Tap at City Hall.	Tap at Experiment Station.	
March 1,	3,100	16	-	14	19	Covered.
2,	1,300	30	-	28	28	Covered.
3,	2,800	34	-	19	30	Covered.
4,	3,300	53	-	51	23	Covered.
5,	12,800	41	-	51	7	Covered.
6,	-	-	-	-	-	-
7,	-	80	43	36	27	Covered.
8,	2,400	73	-	29	15	Covered.
9,	-	-	-	-	34	Covered.
10,	2,700	27	-	37	98	Drained.
11,	4,500	10	-	48	50	Covered.
12,	7,000	46	-	43	51	Covered.
13,	-	-	-	-	-	-
14,	8,300	28	195	137	47	Covered.
15,	4,400	15	-	129	101	Drained.
16,	5,700	52	-	137	31	Covered.
17,	6,300	14	-	119	78	Covered.
18,	2,800	46	-	162	59	Covered.
19,	3,800	21	-	133	49	Covered.
20,	-	-	-	-	-	-
21,	2,500	9	122	94	27	Covered.
22,	2,700	25	-	89	47	Drained.
23,	5,400	22	-	88	31	Covered.
24,	2,300	10	-	19	21	Covered.
25,	1,300	72	-	36	24	Drained.
26,	700	77	-	24	22	Drained.
27,	-	-	-	-	-	-
28,	2,000	25	44	43	22	Covered.
29,	2,500	17	-	23	31	Covered.
30,	1,200	16	-	17	36	Covered.
31,	1,900	17	-	11	24	Covered.
Averages,	3,748	34	101	62	38	-

Daily Bacterial Results, Lawrence City Water.

[Bacteria per Cubic Centimeter.]

Date — 1898.	In River Water.	In Filtered Water from				Condition of Surface when Pumps were Stopped.
		City Filter.	Reservoir Outlet.	Tap at City Hall.	Tap at Experiment Station.	
April 1,	4,500	15	-	21	14	Covered.
2,	2,100	24	-	22	14	Covered.
3,	-	-	-	-	-	-
4,	2,400	10	123	45	22	Covered.
5,	1,400	15	-	63	42	Covered.
6,	700	10	-	57	26	Covered.
7,	1,200	17	-	34	15	Covered.
8,	1,200	17	-	27	32	Covered.
9,	1,400	44	-	32	9	Covered.
10,	-	-	-	-	-	-
11,	1,300	7	36	22	12	Covered.
12,	800	5	-	15	11	Covered.
13,	2,300	18	-	40	30	Covered.
14,	1,300	19	-	25	4	Covered.
15,	2,600	25	-	28	16	Covered.
16,	3,300	12	-	49	3	Covered.
17,	-	-	-	-	-	-
18,	2,800	34	65	37	31	Covered.
19,	-	-	-	-	-	-
20,	2,800	-	-	24	18	Covered.
21,	1,100	31	-	15	9	Covered.
22,	2,200	22	-	17	19	Covered.
23,	5,400	24	-	19	11	Covered.
24,	-	-	-	-	-	-
25,	4,700	42	31	44	26	Covered.
26,	4,600	12	-	26	10	Covered.
27,	1,600	30	-	9	23	Drained.
28,	1,800	-	-	14	22	Drained.
29,	3,400	19	-	10	13	Covered.
30,	1,100	38	-	27	44	Covered.
Averages,	2,320	21	64	25	19	-

Monthly Averages of Bacterial Results from the Lawrence City Water.

Months.	Bacteria per Cubic Centimeter in Water from				
	River.	Effluent at Filter.	Reservoir Outlet.	City Hall Tap.	Experiment Station Tap.
1897.					
May to October, inclusive,	11,000	67	148	123	68
November,	6,644	27	35	43	38
December,	5,581	24	27	26	25
1898.					
January,	6,519	39	46	34	33
February,	4,653	45	39	28	27
March,	3,748	34	101	62	38
April,	2,320	21	64	25	19
Averages,	5,781	37	66	49	35
Per cent which the average number of bacteria removed was of the average number of river bacteria,	-	99.36	98.86	99.15	99.39

The following tables present the averages of the chemical analyses of the river water at the filter and of the filtered water from different points upon the system : —

Merrimack River Water as it flows upon the Lawrence City Filter.

[Parts per 100,000.]

1897.	Temperature. Deg. F.	Color.	Ammonia.			Chlorine.	Nitrogen as		Oxygen Consumed.	Hardness.
			Free.	Albuminoid. Total.	Albuminoid. Soluble.		Nitrates.	Nitrites.		
January,	32	.43	.0086	.0208	.0188	.20	.023	.0000	.41	1.3
February,	33	.37	.0136	.0271	.0218	.31	.016	.0000	.36	1.4
March,	33	.37	.0060	.0186	.0170	.19	.013	.0000	.36	1.0
April,	39	.43	.0044	.0158	.0146	.14	.011	.0000	.36	1.1
May,	65	.42	.0054	.0207	.0177	.07	.011	.0000	.45	1.0
June,	65	.45	.0051	.0159	.0148	.09	.009	.0000	.50	1.2
July,	76	.50	.0051	.0200	.0196	.15	.009	.0001	.48	1.1
August,	70	.53	.0078	.0217	.0191	.16	.012	.0001	.49	1.8
September,	67	.42	.0125	.0213	.0182	.32	.013	.0001	.39	1.9
October,	54	.37	.0181	.0234	.0179	.40	.015	.0004	.32	1.5
November,	42	.56	.0070	.0221	.0207	.24	.014	.0003	.65	1.1
December,	33	.52	.0053	.0160	.0148	.22	.016	.0000	.62	0.9
Averages,	51	.45	.0082	.0203	.0179	.21	.014	.0001	.45	1.3

Effluent from the City Filter.

[Parts per 100,000.]

1897.	Temperature. Deg. F.	Color.	Ammonia. Free.	Ammonia. Albuminoid. Total.	Ammonia. Albuminoid. Soluble.	Chlorine.	Nitrogen as Nitrates.	Nitrogen as Nitrites.	Oxygen Consumed.	Hardness.
January,	34	.40	.0111	.0108	.0100	.23	.042	.0000	.32	1.8
February,	35	.54	.0167	.0114	.0104	.32	.049	.0000	.26	2.1
March,	34	.32	.0075	.0092	.0090	.21	.043	.0000	.24	1.9
April,	47	.41	.0100	.0119	.0095	.18	.040	.0000	.29	1.5
May,	60	.36	.0060	.0103	.0096	.12	.036	.0000	.30	1.2
June,	63	.38	.0080	.0084	.0079	.15	.044	.0000	.34	1.7
July,	73	.44	.0118	.0110	.0102	.19	.035	.0001	.33	2.0
August,	72	.41	.0080	.0091	.0087	.18	.061	.0000	.29	1.8
September,	66	.29	.0062	.0071	.0064	.31	.048	.0000	.22	1.8
October,	57	.34	.0131	.0089	.0086	.40	.035	.0003	.19	1.9
November,	45	.55	.0177	.0094	.0092	.24	.041	.0000	.32	2.3
December,	37	.59	.0127	.0099	.0098	.22	.043	.0000	.47	2.0
Averages,	52	.42	.0107	.0098	.0091	.23	.043	.0000	.30	1.8

Water from the Outlet of the Distributing Reservoir.

[Parts per 100,000.]

1897.	Temperature. Deg. F.	Color.	Ammonia. Free.	Ammonia. Albuminoid. Total.	Ammonia. Albuminoid. Soluble.	Chlorine.	Nitrogen as Nitrates.	Nitrogen as Nitrites.	Oxygen Consumed.	Hardness.
January,	35	.43	.0105	.0112	.0108	.25	.046	.0000	.31	2.0
February,	35	.37	.0100	.0101	.0098	.29	.049	.0000	.26	1.9
March,	35	.35	.0094	.0102	.0099	.21	.048	.0000	.24	1.8
April,	45	.42	.0075	.0114	.0103	.21	.043	.0000	.27	-
May,	59	.33	.0034	.0099	.0089	.14	.042	.0000	.27	-
June,	62	.38	.0033	.0093	.0090	.17	.043	.0000	.32	1.6
July,	72	.37	.0038	.0103	.0099	.21	.040	.0000	.28	1.7
August,	71	.33	.0023	.0093	.0091	.18	.045	.0002	.28	1.8
September,	66	.24	.0022	.0077	.0075	.30	.039	.0000	.25	1.9
October,	55	.21	.0021	.0079	.0075	.39	.045	.0000	.17	1.8
November,	44	.39	.0049	.0092	.0091	.27	.037	.0000	.29	1.6
December,	38	.51	.0079	.0100	.0098	.25	.038	.0000	.39	1.6
Averages,	51	.36	.0056	.0097	.0093	.24	.043	.0000	.28	1.7

Water from a Tap at the Lawrence City Hall.

[Parts per 100,000.]

1897.	Temperature. Deg. F.	Color.	Ammonia. Free.	Ammonia. Albuminoid.	Chlorine.	Nitrogen as Nitrates.	Nitrogen as Nitrites.	Oxygen Consumed.	Hardness.
January,	35	.42	.0094	.0111	.24	.048	.0000	.29	1.8
February,	36	.37	.0094	.0098	.30	.048	.0000	.26	1.9
March,	37	.35	.0078	.0105	.22	.045	.0000	.24	1.8
April,	45	.41	.0070	.0112	.22	.041	.0000	.26	–
May,	58	.32	.0034	.0097	.14	.043	.0000	.26	–
June,	61	.37	.0025	.0098	.17	.044	.0000	.31	1.5
July,	72	.33	.0021	.0088	.21	.041	.0000	.28	1.5
August,	70	.31	.0012	.0088	.19	.046	.0001	.27	1.7
September,	67	.27	.0011	.0062	.29	.041	.0000	.25	1.8
October,	57	.21	.0015	.0074	.38	.047	.0000	.17	1.9
November,	48	.36	.0028	.0094	.31	.037	.0000	.29	1.7
December,	42	.49	.0050	.0096	.25	.040	.0000	.37	1.6
Averages,	52	.35	.0044	.0094	.24	.043	.0000	.27	1.7

Water from a Tap at the Lawrence Experiment Station.

[Parts per 100,000.]

1897.	Temperature. Deg. F.	Color.	Ammonia. Free.	Ammonia. Albuminoid.	Chlorine.	Nitrogen as Nitrates.	Nitrogen as Nitrites.	Oxygen Consumed.	Hardness.
January,	–	.42	.0063	.0109	.24	.052	.0000	.29	1.9
February,	35	.36	.0077	.0096	.30	.050	.0000	.24	1.9
March,	41	.35	.0035	.0097	.22	.041	.0000	.23	1.8
April,	45	.40	.0048	.0116	.21	.044	.0000	.26	1.6
May,	55	.28	.0019	.0082	.15	.044	.0000	.25	1.4
June,	59	.36	.0009	.0079	.17	.044	.0000	.29	1.6
July,	69	.32	.0017	.0086	.21	.047	.0000	.26	1.6
August,	68	.27	.0008	.0080	.19	.046	.0000	.25	1.6
September,	66	.20	.0007	.0060	.28	.042	.0000	.24	1.8
October,	59	.18	.0007	.0066	.38	.045	.0000	.15	1.8
November,	52	.31	.0011	.0080	.31	.037	.0000	.27	1.7
December,	47	.45	.0024	.0091	.25	.043	.0000	.35	1.7
Averages,	54	.33	.0027	.0087	.24	.045	.0000	.26	1.7

Sewage Disposal

of

Cities and Towns in Massachusetts

by

INTERMITTENT FILTRATION.

Sewage Disposal of Cities and Towns in Massachusetts by Intermittent Filtration.

During the year 1897 works were constructed at Spencer for the purification of the sewage of the greater portion of the main village by intermittent filtration, and at the end of the year there were in Massachusetts 12 cities and towns, having an aggregate population of 105,902, in which the purification of the sewage was effected by filtration through beds of gravel or sand. The sewage of several large institutions in the State is also disposed of by this method.

Sewage Disposal at Brockton.

The sewage of the city of Brockton is collected in a covered masonry reservoir which is of sufficient size to store the night flow of sewage, making it necessary to pump only during a part of the day. During the time that the sewage is stored in this reservoir a large amount of the solid matter in suspension settles to the bottom of the reservoir, and it is the custom, when pumping, to agitate the sewage at the bottom of the reservoir just before the reservoir is emptied and thus mix the sludge at the bottom with the small amount of sewage remaining at the reservoir. This sludge remains in the force main until pumping is resumed the following day, when it is discharged at the field. In order to indicate the average character of Brockton sewage it has been necessary to take two samples, one representing the weak sewage pumped from the upper portion of the reservoir and the other the sewage containing the sludge which settles to the bottom. The sewage containing the sludge is said to represent about 10 per cent. of the total amount of sewage. The following table, taken from the report of the city engineer of Brockton for the year 1897, gives the average amount of sewage disposed of at the filtration area, and the average temperature of the sewage as it reached the beds: —

Month.	Average Flow per 24 Hours (Gallons).	Temperature of Sewage at Beds (Degrees F.).
January,	614,200	45.9
February,	542,300	43.6
March,	659,000	43.1
April,	701,750	45.4
May,	530,300	50.0
June,	564,800	54.2
July,	536,600	58.6
August,	568,000	60.8
September,	467,900	56.8
October,	369,200	57.9
November,	492,350	54.1
December,	597,420	49.2

The results of frequent examinations of the sewage and of the effluent from these works made during 1898 are given in the following tables: —

Chemical Examination of Sewage from Brockton.

[Parts per 100,000.]

Number.	Date of Collection.	Residue on Evaporation.					
		TOTAL RESIDUE.			LOSS ON IGNITION.		
		Total.	Dissolved.	Suspended.	Total.	Dissolved.	Suspended.
	1897.						
18402	Feb. 1	51.80	30.20	21.60	28.60	12.00	16.60
18883	Mar. 23	42.20	23.40	18.80	23.40	8.80	14.60
19042	Apr. 14	31.00	23.20	7.80	14.00	7.20	6.80
19229	May 12	37.40	28.10	9.30	16.80	8.80	8.00
19434	June 9	37.80	30.30	7.50	13.80	7.30	6.50
19787	July 14	32.40	27.70	4.70	11.60	10.50	1.10
20082	Aug. 11	40.20	31.40	8.80	15.00	7.80	7.20
20500	Sept. 15	41.20	34.00	7.20	18.40	12.40	6.00
20780	Oct 13	43.20	36.00	7.20	24.40	16.60	7.80
21112	Nov. 10	35.00	29.20	5.80	17.40	12.20	5.20
21580	Dec. 15	38.40	29.00	9.40	19.00	10.90	8.10
Av.	....	39.15	29.32	9.83	18.40	10.41	7.99

Chemical Examination of Sewage from Brockton — Concluded.

[Parts per 100,000.]

Number.	Ammonia.				Chlorine.	Nitrogen as		Oxygen Consumed.	
	Free.	ALBUMINOID.				Nitrates.	Nitrites.	Unfiltered.	Filtered.
		Total.	Dissolved.	Suspended.					
18402	1.4400	0.7280	0.3480	0.3800	6.06	.0070	.0000	5.73	2.19
18883	1.2000	0.4370	0.2150	0.2220	4.20	.0030	.0000	3.44	1.16
19042	1.5200	0.4120	0.2320	0.1800	4.47	.0030	.0001	2.56	1.52
19229	1.6000	0.4620	0.2340	0.2280	6.07	.0030	.0000	5.12	1.96
19434	2.0000	0.4640	0.2360	0.2280	7.55	.0030	.0000	3.20	2.24
19787	1.6400	0.3120	0.1500	0.1620	6.70	.0000	.0000	3.51	2.53
20082	2.4000	0.4360	0.2440	0.1920	8.30	.0030	.0000	5.50	2.57
20500	3.2800	0.5000	0.3000	0.2000	7.30	.0000	.0000	3.28	2.16
20780	3.3600	1.0700	0.7900	0.2800	5.89	.0030	.0000	0.47	0.33
21112	3.6000	0.7800	0.4900	0.2900	6.52	.0020	.0000	3.84	2.80
21580	3.9600	0.7000	0.4100	0.2900	6.18	.0050	.0000	3.76	2.40
Av.	2.3636	0.5728	0.3317	0.2411	6.29	.0029	.0000	3.67	1.99

Odor, offensive. —— The samples were collected as the sewage flowed out upon the filter beds. The first two samples represent a mixture of the sludge from the bottom of the reservoir with the supernatant sewage, the amount of each being proportional to the amount pumped during the day on which the sample was collected. The remaining samples represent the supernatant sewage only.

Chemical Examination of the Sewage pumped from the Bottom of the Sewage Reservoir at Brockton.

[Parts per 100,000.]

Number.	Date of Collection.	Residue on Evaporation.					
		Total Residue.			Loss on Ignition.		
		Total.	Dissolved.	Suspended.	Total.	Dissolved.	Suspended.
	1897.						
19041	Apr. 14	321.00	29.20	291.80	255.00	12.20	242.80
19228	May 12	292.60	35.30	257.30	225.40	15.00	210.40
19433	June 9	217.00	41.00	176.00	152.00	14.10	137.90
19786	July 14	165.00	35.20	129.80	102.00	13.20	88.80
20083	Aug. 11	316.00	38.90	277.10	180.00	16.70	163.30
20499	Sept. 15	201.20	37.40	163.80	146.00	16.00	130.00
20779	Oct. 13	192.80	39.00	153.80	149.60	18.60	131.00
21111	Nov 10	221.60	37.20	184.40	158.00	17.00	141.00
21579	Dec. 15	178.80	35.20	143.60	136.00	16.40	119.60
Av.	....	234.00	36.49	197.51	167.11	15.47	151.64

Chemical Examination of the Sewage pumped from the Bottom of the Sewage Reservoir at Brockton — Concluded.

[Parts per 100,000.]

Number.	Ammonia.				Chlorine.	Nitrogen as		Oxygen Consumed.	
	Free.	Albuminoid.				Nitrates.	Nitrites.	Unfiltered.	Filtered.
		Total.	Dissolved.	Suspended.					
19041	2.3600	3.0000	0.3700	2.6300	4.13	.0030	.0000	14.96	2.80
19228	3.8400	3.5800	0.4400	3.1400	5.50	.0030	.0000	22.88	3.44
19433	4.0800	3.8800	0.5100	3.3700	9.63	.0000	.0000	23.60	3.20
19786	3.6800	2.8700	0.2800	2.5900	7.55	.0000	.0000	22.81	3.81
20083	4.4000	4.8700	0.3400	4.5300	7.96	.0050	.0000	32.25	4.33
20499	4.8000	2.5700	0.4400	2.1300	7.10	.0000	.0000	21.68	3.36
20779	5.2000	3.5400	0.7700	2.7700	5.58	.0020	.0002	27.44	3.92
21111	5.7600	5.3600	2.2000	3.1600	7.60	.0030	.0000	28.72	3.68
21579	5.6000	4.1500	2.0000	2.1500	6.32	.0070	.0000	27.84	3.20
Av.	4.4133	3.7578	0.8167	2.9411	6.82	.0026	.0000	24.69	3.53

Odor, offensive. — The samples were collected as the sewage flowed out on the filter beds, and represent the sludge which settles to the bottom of the reservoir mixed with a small amount of the supernatant sewage.

Chemical Examination of Effluent from an Underdrain at the Brockton Sewage Disposal Works.

[Parts per 100,000.]

Number.	Date of Collection.	Appearance.			Odor.		Residue on Evaporation.
		Turbidity.	Sediment.	Color.	Cold.	Hot.	
	1897.						
18403	Feb. 1	None.	None.	.00	Decidedly disagreeable.	Decidedly disagreeable.	20.20
18884	Mar. 26	None.	None.	.02	Faintly musty and unpleasant.	Distinctly musty and unpleasant.	19.70
19043	Apr. 14	None.	None.	.02	Faintly unpleasant.	Faintly mouldy.	23.90
19230	May 12	None.	None.	.00	None.	Distinctly musty and unpleasant.	29.30
19436	June 9	Slight.	None.	.03	Faintly unpleasant.	Distinctly musty and unpleasant.	31.40
19788	July 14	None.	None.	.01	None.	Distinctly musty.	31.10
20084	Aug. 11	None.	V. slight.	.02	None.	None.	31.30
20501	Sept. 15	None.	None.	.05	None.	None.	27.70
20782	Oct. 13	None.	V. slight.	.00	Faintly mouldy.	Distinctly mouldy and unpleasant.	32.50
21113	Nov. 10	None.	None.	.02	None.	Faintly earthy.	31.20
21581	Dec. 15	V. slight.	None.	.06	None.	Strongly musty.	27.00
Av.	....	....	....	.02	....	....	27.75

Chemical Examination of Effluent from an Underdrain at the Brockton Sewage Disposal Works — Concluded.

[Parts per 100,000.]

Number.	Ammonia.		Chlorine.	Nitrogen as		Oxygen Consumed.	Hardness.	Iron.
	Free.	Albuminoid.		Nitrates.	Nitrites.			
18403	.1632	.0084	4.22	0.6000	.0018	.15	3.8	.0000
18884	.2960	.0170	3.97	0.9000	.0030	.15	6.0	.0000
19043	.2400	.0160	3.85	1.0500	.0030	.12	6.4	.0000
19230	.0832	.0094	3.76	1.6000	.0016	.12	7.7	.0000
19436	.0608	.0106	4.38	1.7000	.0025	.08	9.1	.0000
19788	.0216	.0050	5.50	1.0500	.0010	.15	8.9	.0000
20084	.0080	.0074	5.48	1.0000	.0002	.09	7.3	.0000
20501	.0042	.0058	5.40	1.1500	.0003	.07	4.3	.0000
20782	.0212	.0148	5.38	1.0000	.0018	.11	8.3	.0000
21113	.0400	.0102	5.72	1.7200	.0013	.06	9.3	.0010
21581	.0640	.0104	5.11	1.7000	.0009	.06	10.0	.0020
Av.	.0911	.0105	4.80	1.2245	.0016	.11	7.4	.0003

The samples were collected from the underdrain on Pearl Street, which receives, in addition to the effluent from several of the filter beds, a large amount of ground water from the territory in the vicinity of the filtration area.

Sewage Disposal at Framingham.

Chemical Examination of Sewage from Framingham.

[Parts per 100,000.]

Number.	Date of Collection.	Residue on Evaporation. Total Residue. Total.	Total Residue. Dissolved.	Total Residue. Suspended.	Loss on Ignition. Total.	Loss on Ignition. Dissolved.	Loss on Ignition. Suspended.
	1897.						
18309	Jan. 20	1368.00	144.60	1223.40	1274.00	94.40	1179.60
18480	Feb. 10	534.00	32.40	501.60	499.00	10.40	488.60
18751	Mar. 10	491.00	78.60	412.40	436.00	40.00	396.00
19036	April 14	297.00	35.60	261.40	245.00	9.00	236.00
19236	May 12	53.00	33.90	19.10	25.20	9.90	15.30
19426	June 9	171.00	47.60	123.40	123.00	17.40	105.60
19795	July 14	359.00	48.70	310.30	285.00	15.70	269.30
20068	Aug. 11	198.00	52.70	145.30	140.00	17.30	122.70
20493	Sept. 15	314.40	69.40	245.00	230.80	19.00	211.80
20774	Oct. 13	726.00	46.80	679.20	645.20	15.20	630.00
21106	Nov. 10	217.60	41.00	176.60	168.80	13.00	155.80
21574	Dec. 15	65.80	51.20	14.60	21.00	11.10	9.90
Av.	....	399.57	56.88	342.69	341.08	22.70	318.38

Chemical Examination of Sewage from Framingham — Concluded.

[Parts per 100,000.]

Number.	Ammonia. Free.	Ammonia. Albuminoid. Total.	Albuminoid. Dissolved.	Albuminoid. Suspended.	Chlorine.	Nitrogen as Nitrates.	Nitrogen as Nitrites.	Oxygen Consumed. Unfiltered.	Oxygen Consumed. Filtered.
18309	2.9600	4.9600	0.5300	4.4300	6.20	.0000	.0000	50.66	8.18
18480	2.0400	2.6000	0.4800	2.1200	8.33	.0000	.0000	31.60	2.00
18751	2.5600	2.2100	0.5100	1.7100	9.65	.0000	.0000	16.00	2.52
19036	1.6400	2.9500	0.2600	2.6900	8.22	.0080	.0001	15.92	2.96
19236	2.0000	0.5620	0.2320	0.3300	7.80	.0030	.0000	4.00	1.72
19426	4.8000	1.7300	0.5400	1.1900	10.47	.0030	.0000	14.40	3.04
19795	3.6800	4.5900	0.3000	4.2900	13.64	.0000	.0000	33.26	3.51
20068	3.0400	4.1100	0.3700	3.7400	9.10	.0030	.0000	21.75	6.55
20493	4.0000	3.5100	0.3800	3.1300	23.90	.0000	.0000	31.60	2.72
20774	3.3600	3.8000	0.4400	3.3600	12.56	.0030	.0000	31.52	3.04
21106	5.0000	2.7700	0.5400	2.2300	11.30	.0000	.0000	23.60	3.44
21574	2.6000	0.7800	0.4600	0.3200	17.50	.0030	.0120	4.40	2.40
Av.	3.1400	2.8810	0.4202	2.4617	11.56	.0019	.0010	23.23	3.51

Odor, offensive. — The sewage was collected as it flowed out upon the beds.

Chemical Examination of Effluent from the East Underdrain of the Framingham Filter Beds

[Parts per 100,000.]

Number.	Date of Collection.	Appearance.			Odor.		Residue on Evaporation.
		Turbidity.	Sediment.	Color.	Cold.	Hot.	
	1897.						
18311	Jan. 20	None.	V. slight.	.02	Faintly unpleasant.	Faintly unpleasant.	31.00
18482	Feb. 10	V. slight, milky.	None.	.03	Faintly unpleasant.	Faintly unpleasant.	27.40
18753	Mar. 10	V. slight.	V. slight.	.05	Distinctly musty and unpleasant.	Decidedly musty and unpleasant.	22.70
19038	Apr. 14	None.	None.	.03	Distinctly unpleasant.	Decidedly musty and disagreeable.	28.20
19238	May 12	None.	V. slight.	.02	Faintly unpleasant.	Distinctly unpleasant.	37.70
19428	June 9	V. slight.	V. slight.	.03	Faintly unpleasant.	Distinctly unpleasant.	35.80
19797	July 14	None.	None.	.00	Faintly musty.	None.	42.20
20070	Aug. 11	None.	None.	.04	Faintly musty.	Faintly musty.	40.50
20495	Sept. 15	None.	None.	.00	Faintly musty.	None.	40.90
20776	Oct. 13	None.	None.	.00	Faintly musty.	Distinctly musty.	41.70
21108	Nov. 10	V. slight.	V. slight.	.07	Faintly musty.	Faintly vegetable.	36.10
21576	Dec. 15	Slight.	V. slight.	.07	Faintly mouldy.	Strongly mouldy.	35.90
Av.	....	....	....	.03	....	....	35.01

Chemical Examination of Effluent from the East Underdrain of the Framingham Filter Beds — Concluded.

[Parts per 100,000.]

Number.	Ammonia.		Chlorine.	Nitrogen as		Oxygen Consumed.	Hardness.	Iron.
	Free.	Albuminoid.		Nitrates.	Nitrites.			
18311	.2320	.0160	6.27	1.1300	.0015	.15	5.7	.0000
18482	.1920	.0232	7.70	0.7800	.0120	.17	4.3	.0040
18753	.4160	.0200	6.02	0.4000	.0150	.26	4.0	.0120
19038	.1720	.0050	6.22	1.0000	.0022	.15	5.7	.0060
19238	.1344	.0120	7.68	0.9500	.0008	.16	8.4	.0000
19428	.1840	.0100	7.70	1.1600	.0022	.11	8.7	.0000
19797	.0880	.0140	9.05	1.0000	.0045	.18	9.9	.0010
20070	.0848	.0088	10.08	1.1000	.0040	.13	9.1	.0000
20495	.0280	.0072	10.05	1.0250	.0050	.13	8.0	.0000
20776	.0110	.0108	11.04	0.6300	.0010	.14	7.9	.0000
21108	.0896	.0112	9.49	1.2000	.0044	.11	8.9	.0060
21576	.0705	.0115	8.82	1.4600	.0001	.08	10.8	.0020
Av.	.1426	.0125	8.34	0.9862	.0044	.15	7.6	.0026

The samples were collected from the underdrain at its outlet.

Chemical Examination of Effluent from the West Underdrain of the Framingham Filter Beds.

[Parts per 100,000.]

Number.	Date of Collection.	Appearance.			Odor.		Residue on Evaporation.
		Turbidity.	Sediment	Color.	Cold.	Hot.	
	1897.						
18310	Jan. 20	None.	V. slight.	.02	None.	Distinctly mouldy and unpleasant.	27.10
18481	Feb. 10	None.	V. slight	.05	Faintly unpleasant.	Faintly musty and unpleasant.	23.20
18752	Mar. 10	V. slight.	V. slight.	.07	Distinctly musty and unpleasant.	Decidedly musty and disagreeable.	18.60
19037	Apr. 14	None.	None.	.05	Distinctly unpleasant.	Decidedly musty and unpleasant.	22.20
19237	May 12	Slight.	Slight.	.18	Distinctly unpleasant.	Distinctly disagreeable.	29.20
19427	June 9	V. slight.	V. slight.	.10	Faintly unpleasant.	Decidedly musty and unpleasant.	30.50
19796	July 14	V. slight.	Slight.	.50	Faintly musty.	Distinctly musty.	29.60
20069	Aug. 11	None.	V. slight.	.08	Distinctly musty.	Distinctly musty.	42.90
20494	Sept. 15	None.	V. slight.	.01	None.	Faintly musty.	41.50
20775	Oct. 13	None.	None.	.20	Faintly musty.	Distinctly musty.	31.50
21107	Nov. 10	V. slight.	V. slight.	.11	None.	Faintly vegetable.	28.50
21575	Dec. 15	Great.	Cons.	.34	Faintly musty & mouldy.	Offensive.	21.70
Av.	....	....	....	.14	....	....	28.87

Chemical Examination of Effluent from the West Underdrain of the Framingham Filter Beds — Concluded.

[Parts per 100,000.]

Number.	Ammonia.		Chlorine.	Nitrogen as		Oxygen Consumed.	Hardness.	Iron.
	Free.	Albuminoid.		Nitrates.	Nitrites.			
18310	.3200	.0440	5.36	1.0500	.0010	.12	6.4	.0000
18481	.0720	.0102	5.60	0.5750	.0032	.14	5.0	.0200
18752	.0920	.0150	4.80	0.4900	.0010	.18	3.6	.0080
19037	.1680	.0100	4.30	0.7000	.0012	.15	5.6	.0050
19237	.1600	.0160	5.53	0.7800	.0060	.21	7.0	.0400
19427	.1880	.0130	5.95	0.6200	.0020	.09	8.6	.0450
19769	.0840	.0400	6.70	0.1375	.0040	.84	7.9	.0210
20069	.1360	.0120	8.45	1.2000	.0065	.16	9.9	.0010
20494	.0768	.0094	9.30	1.0500	.0040	.13	4.6	.0010
20775	.0392	.0150	7.78	0.5000	.0005	.28	6.6	.0070
21107	.0552	.0130	7.30	0.9600	.0019	.15	7.7	.0100
21575	.0985	.0175	5.65	0.4750	.0016	.27	6.3	.0250
Av.	.1241	.0179	6.39	0.7115	.0027	.23	6.6	.0152

The samples were collected from the underdrain at its outlet.

Chemical Examination of Water from a Spring near Bannister Brook which receives Effluent from the Framingham Filter Beds.

[Parts per 100,000.]

Number.	Date of Collection.	Appearance.			Odor.		Residue on Evaporation.
		Turbidity.	Sediment.	Color.	Cold.	Hot.	
	1897.						
18313	Jan. 20	None.	V. slight.	.00	None.	None.	21.00
18483	Feb. 10	None.	None.	.00	None.	None.	18.90
18755	Mar. 10	None.	None.	.00	None.	None.	19.40
19039	April 14	None.	None.	.00	None.	None.	20.30
19240	May 12	None.	None.	.05	None.	None.	20.00
19429	June 9	None.	V. slight.	.00	None.	None.	18.80
19864	July 22	None.	V. slight.	.02	None.	None.	20.10
20071	Aug. 11	None.	None.	.01	None.	None.	19.80
20496	Sept. 15	None.	V. slight.	.00	None.	None.	21.40
20777	Oct. 13	None.	None.	.00	None.	None.	19.40
21110	Nov. 10	None.	None.	.04	None.	None.	18.80
21578	Dec. 15	V. slight.	Cons.	.05	None.	None.	18.50
Av.	....	....	....	.01	....	....	19.70

Chemical Examination of Water from a Spring near Bannister Brook which receives Effluent from the Framingham Filter Beds — Concluded.

[Parts per 100,000.]

Number.	Ammonia.		Chlorine.	Nitrogen as		Oxygen Consumed.	Hardness.	Iron.
	Free.	Albuminoid.		Nitrates.	Nitrites.			
18313	.0002	.0022	3.62	.7750	.0000	.03	5.4	.0000
18483	.0002	.0030	3.78	.8000	.0000	.00	5.4	.0000
18755	.0012	.0016	4.00	.6200	.0000	.00	6.3	.0000
19039	.0000	.0010	3.98	.7000	.0000	.04	5.4	.0000
19240	.0008	.0018	3.70	.5000	.0000	.01	6.1	.0000
19429	.0012	.0032	3.30	.5500	.0000	.00	5.4	.0000
19864	.0004	.0030	4.00	.4100	.0000	.00	5.7	.0010
20071	.0018	.0074	3.90	.5500	.0003	.05	6.3	.0000
20496	.0004	.0004	3.92	.5500	.0000	.03	8.4	.0020
20777	.0002	.0038	3.60	.4500	.0000	.01	5.1	.0010
21110	.0006	.0042	3.72	.1800	.0000	.02	6.0	.0020
21578	.0008	.0036	3.89	.7200	.0010	.01	7.3	.0020
Av.	.0006	.0029	3.78	.5671	.0001	.02	6.1	.0007

Chemical Examination of Water from Bannister Brook below the Framingham Filter Beds.

[Parts per 100,000.]

Number.	Date of Collection.	Appearance.			Residue on Evaporation.		Ammonia.				Chlorine.	Nitrogen as		Oxygen Consumed.	Hardness.
								Albuminoid.							
		Turbidity.	Sediment.	Color.	Total.	Loss on Ignition.	Free.	Total.	Dissolved.	Sus-pended.		Nitrates.	Nitrites.		
	1897.														
19865	July 22	V. slight.	Slight.	.12	22.40	6.05	.0326	.0126	.0078	.0048	4.70	.1100	.0030	.20	5.4
20072	Aug. 11	None.	Slight.	.19	20.50	4.15	.0152	.0116	.0096	.0020	4.10	.2100	.0035	.27	5.6
20498	Sept. 15	V. slight.	Cons.	.08	21.05	11.10	.0006	.0140	.0080	.0060	4.50	.4250	.0018	.21	7.1
Av..	....	....	....	.13	21.32	7.10	.0161	.0127	.0085	.0042	4.43	.2483	.0028	.23	6.0

Odor, vegetable and musty. —— The samples were collected from the brook, at the first road crossing below the sewage field.

Sewage Disposal at Gardner.

Chemical Examination of Sewage from Gardner.

[Parts per 100,000.]

Number.	Date of Collection.	Residue on Evaporation. Total Residue. Total.	Dissolved.	Suspended.	Loss on Ignition. Total.	Dissolved.	Suspended.
	1897.						
18299	Jan. 20	35.80	19.40	16.40	21.20	8.30	12.90
18476	Feb. 10	38.60	20.40	18.20	25.80	9.00	16.80
18749	Mar. 10	35.20	19.00	16.20	20.40	8.20	12.20
19044	Apr. 14	56.00	42.00	14.00	34.00	29.00	5.00
19231	May 12	41.40	20.20	21.20	24.60	7.40	17.20
19437	June 9	33.00	16.60	16.40	18.00	5.80	12.20
19856	July 21	27.80	20.60	7.20	10.00	4.60	5.40
20078	Aug. 11	47.00	33.60	13.40	19.60	8.60	11.00
20536	Sept. 15	34.40	17.20	17.20	20.60	6.50	14.10
20783	Oct. 13	54.40	26.40	28.00	34.00	13.40	20.60
21114	Nov. 10	27.80	17.30	10.50	15.80	6.80	9.00
21583	Dec. 15	22.60	13.30	9.30	7.00	4.40	2.60
Av.	....	37.83	22.17	15.66	20.92	9.33	11.59

Chemical Examination of Sewage from Gardner — Concluded

[Parts per 100,000.]

Number.	Ammonia. Free.	Albuminoid. Total.	Dissolved.	Suspended.	Chlorine.	Nitrogen as Nitrates.	Nitrites.	Oxygen Consumed. Unfiltered.	Filtered.
18299	1.9200	0.7540	0.4160	0.3380	3.20	.0030	.0000	6.06	3.14
18476	2.0800	0.7260	0.3660	0.3600	3.40	.0030	.0000	4.80	3.00
18749	1.9200	0.5940	0.3120	0.2820	2.78	.0050	.0175	3.68	1.68
19044	2.1600	1.4600	1.2920	0.1680	3.42	.0030	.0200	4.92	2.52
19231	2.0800	0.4700	0.3680	0.1020	3.65	.0030	.0000	2.96	1.20
19437	1.5200	0.5320	0.4840	0.0480	2.30	.0030	.0000	2.88	1.52
19856	1.0240	0.4440	0.1420	0.3020	3.26	.0020	.0000	2.51	1.23
20078	0.9600	0.6200	0.2560	0.3640	3.80	.0700	.0160	5.38	1.83
20536	1.1200	0.4660	0.1880	0.2780	2.60	.0030	.0000	3.60	1.08
20783	2.6000	1.2200	0.9400	0.2800	3.80	.0030	.0000	7.84	3.04
21114	1.8800	0.8100	0.5500	0.2600	2.51	.0020	.0080	3.12	2.24
21583	0.9600	0.4100	0.2800	0.1300	1.71	.1540	.0560	1.32	0.59
Av.	1.6853	0.7089	0.4662	0.2427	3.04	.0212	.0098	4.09	1.92

Odor, offensive. —— The sewage was collected as it flowed upon the beds.

Chemical Examination of Effluent from the Main Underdrain of the Gardner Filter Beds.

[Parts per 100,000.]

Number.	Date of Collection.	Appearance.			Odor.		Residue on Evaporation.
		Turbidity.	Sediment.	Color.	Cold.	Hot.	
	1897.						
18300	Jan. 20	Slight.	Slight.	0.25	Distinctly disagreeable.	Decidedly disagreeable.	14.80
18477	Feb. 10	Distinct.	Cons.	0.50	Distinctly musty and disagreeable.	Decidedly musty and disagreeable.	13.70
18750	Mar. 10	Distinct.	Slight.	0.90	Distinctly musty and disagreeable.	Distinctly musty and disagreeable.	13.30
19045	April 14	Distinct.	Slight.	1.10	Distinctly disagreeable.	Distinctly musty and disagreeable.	17.80
19232	May 12	Distinct.	Slight.	0.43	Distinctly musty and disagreeable.	Decidedly musty and disagreeable.	13.80
19438	June 9	Slight.	Slight.	0.70	Decidedly disagreeable.	Decidedly disagreeable.	16.10
19857	July 21	Slight.	Slight.	0.40	Distinctly disagreeable.	Decidedly musty and disagreeable.	19.80
20079	Aug. 11	Slight.	V. slight.	0.20	Distinctly musty and disagreeable.	Distinctly musty.	15.20
20537	Sept. 15	V. slight, milky.	V. slight.	0.10	Distinctly musty.	Distinctly musty and oily.	19.70
20784	Oct. 13	None.	None.	0.07	Distinctly disagreeable.	Distinctly disagreeable.	23.70
21115	Nov. 10	Slight.	V. slight.	0.11	Distinctly earthy.	Distinctly earthy.	16.40
21584	Dec. 15	Decided.	V. slight.	0.30	Decidedly unpleasant.	V. offensive.	13.60
Av.	....	....	....	0.42	....	....	16.49

Chemical Examination of Effluent from the Main Underdrain of the Gardner Filter Beds — Concluded.

[Parts per 100,000.]

Number.	Ammonia.		Chlorine.	Nitrogen as		Oxygen Consumed.	Hardness.	Iron.
	Free.	Albuminoid.		Nitrates.	Nitrites.			
18300	0.9800	0.0940	2.71	0.3400	0.0030	2.19	3.2	.0700
18477	1.4400	0.0860	2.70	0.1500	0.0090	0.63	2.5	.1750
18750	0.5600	0.0390	2.70	0.0750	0.0060	0.72	2.9	.1100
19045	0.9760	0.0540	3.00	0.5000	0.0150	0.51	4.0	.3000
19232	0.7200	0.0400	2.85	0.2900	0.0150	0.34	3.1	.0850
19438	0.6400	0.0640	2.25	0.4100	0.0120	0.38	4.6	.1500
19857	0.2440	0.0270	2.80	0.3750	0.0040	0.30	5.0	.0780
20079	0.1920	0.0258	2.58	0.3500	0.0050	0.27	5.0	.0600
20537	0.1040	0.0468	2.75	0.5500	0.0030	0.31	6.1	.0008
20784	0.0960	0.0238	1.84	0.9700	0.0018	0.20	6.1	.0020
21115	0.2040	0.0300	2.57	1.1000	0.0350	0.27	6.0	.0040
21584	0.5600	0.0760	2.53	0.4000	0.0220	0.50	6.9	.0650
Av..	0.5597	0.0505	2.61	0.4592	0.0109	0.55	4.6	.0916

The samples were collected from the main underdrain at the point where it discharges into Pond brook.

Chemical Examination of Water from Pond Brook above the Gardner Filter Beds.

[Parts per 100,000.]

Number.	Date of Collection.	Appearance.			Residue on Evaporation.		Ammonia.				Chlorine.	Nitrogen as		Oxygen Consumed.	Hardness.
		Turbidity.	Sediment.	Color.	Total.	Loss on Ignition.	Free.	Albuminoid. Total.	Albuminoid. Dissolved.	Albuminoid. Suspended.		Nitrates.	Nitrites.		
	1897.														
19858	July 21	V. slight.	Slight.	.68	12.00	2.95	.0260	.0246	.0210	.0036	2.14	.1000	.0045	.56	4.0
20080	Aug. 11	Slight.	Slight.	.46	14.75	3.80	.0224	.0242	.0190	.0052	2.40	.0800	.0035	.51	4.9
20538	Sept. 15	Slight.	V. slight.	.30	26.20	9.00	.0816	.0234	.0150	.0084	5.34	.2500	.0009	.18	9.3
Av.	....	....	....	.48	17.65	5.25	.0433	.0240	.0183	.0057	3.29	.1433	.0030	.42	6.1

Odor, distinctly vegetable, and of the first and last samples also musty.—The samples were collected from the brook above the point where it is crossed by the main sewer leading to the filter beds.

Chemical Examination of Water from Pond Brook below the Gardner Filter Beds.

[Parts per 100,000.]

Number.	Date of Collection.	Appearance.			Residue on Evaporation.		Ammonia.				Chlorine.	Nitrogen as		Oxygen Consumed.	Hardness.
		Turbidity.	Sediment.	Color.	Total.	Loss on Ignition.	Free.	Albuminoid. Total.	Albuminoid. Dissolved.	Albuminoid. Suspended.		Nitrates.	Nitrites.		
	1897.														
19859	July 21	V. slight.	Slight.	.75	12.10	3.60	.0464	.0268	.0236	.0032	2.03	.0680	.0040	.57	3.9
20081	Aug. 11	Slight.	Slight.	.44	14.10	3.60	.0512	.0234	.0212	.0022	2.40	.1600	.0040	.43	4.6
20539	Sept. 15	Slight, milky.	Slight, iron.	.30	29.55	7.65	.0656	.0204	.0120	.0084	6.56	.0400	.0003	.13	13.0
Av.	....	....	....	.50	18.58	4.95	.0544	.0235	.0189	.0046	3.66	.0893	.0028	.38	7.2

Odor, distinctly vegetable and musty.—The samples were collected from the brook below the filter beds and below the point where effluent from the filter beds enters the stream.

Sewage Disposal at Leicester.

Population in 1895, 3,239. A system of sewerage and sewage disposal was introduced into the town of Leicester in the years 1895 and 1896. At the end of the year 1897 about 1.7 miles of sewers had been constructed, most of which are provided with underdrains, and 70 connections had been made with the sewers.

The method of disposal during the first two years of the operation of the works was to discharge the sewage into an open ditch from 600 to 800 feet long, running around a gravelly knoll, after sedi-

Chemical Examination of

[Parts per 100,000.]

	Number.	Date of Collection.	Residue on Evaporation.					
			Total Residue.			Loss on Ignition.		
			Total.	Dissolved.	Suspended.	Total.	Dissolved.	Suspended.
1	18218	**1896.** Dec. 31	118.40	109.80	8.60	80.60	71.80	8.80
2	18385	**1897.** Jan. 27	102.40	85.00	17.40	56.00	46.60	9.40
3	18485	Feb. 10	40.80	25.20	15.60	23.80	13.20	10.60
4	18804	Mar. 17	90.60	78.00	12.60	59.80	49.20	10.60
5	18941	April 1	167.60	158.80	8.80	119.40	111.40	8.00
6	19046	April 14	88.00	60.60	27.40	50.00	34.00	16.00
7	19246	May 12	96.80	68.70	28.10	52.40	27.70	24.70
8	19431	June 9	82.60	76.40	6.20	48.40	42.60	5.80
9	19791	July 14	63.60	49.80	13.80	34.20	25.00	9.20
10	20075	Aug. 11	91.40	73.00	18.40	51.40	37.90	13.50
11	20544	Sept. 16	78.40	65.40	13.00	42.40	30.40	12.00
12	20795	Oct. 13	86.40	79.40	7.00	50.60	46.60	4.00
13	21118	Nov. 10	74.00	68.80	5.20	43.20	38.00	5.20
14	21585	Dec. 15	39.00	31.80	7.20	17.80	14.80	3.00
15	Av.*	....	84.02	70.85	13.17	49.64	39.73	9.91

* Where more than one sample was collected in a month, the mean analysis for that month has been used in making the average.

mentation in a settling tank. The sludge was discharged on a filter bed prepared for the purpose.

In the fall of 1896 two filter beds were prepared to receive the supernatant liquid from the settling tank, and since that time five other beds have been prepared. Each of the beds has an area of 300 square feet and is thoroughly underdrained. The material of which the beds are composed is very fine so that the amount of sewage which can be treated upon them is quite small, and the ditch around the gravelly knoll is still frequently used, especially during the colder months.

Sewage from Leicester.

[Parts per 100,000.]

Ammonia.				Chlorine.	Nitrogen as		Oxygen Consumed.		
Free.	Albuminoid.				Nitrates.	Nitrites.	Unfiltered.	Filtered.	
	Total.	Dissolved.	Suspended.						
4.6000	0.9900	0.4700	0.5200	8.64	.0020	.0000	42.40	41.80	1
3.8400	0.8900	0.7400	0.1500	6.60	.0000	.0000	28.54	19.97	2
2.1200	0.6000	0.3200	0.2800	2.58	.0050	.0000	6.88	4.72	3
2.3600	0.7500	0.4800	0.2700	7.00	.0000	.0038	23.44	21.92	4
3.2000	0.8400	0.5700	0.2700	8.50	.0000	.0000	45.92	42.80	5
2.4000	0.6000	0.3500	0.2500	4.45	.0030	.0110	19.36	15.76	6
2.0800	0.7740	0.3980	0.3760	5.24	-	.0000	22.24	18.48	7
4.1600	0.7200	0.4000	0.3200	4.16	.0000	.0000	20.72	18.88	8
1.7600	0.6800	0.3420	0.3380	4.88	.0000	.0000	19.05	14.42	9
2.5600	1.1200	0.5220	0.5980	6.60	.0000	.0000	28.55	25.12	10
2.4700	0.7900	0.3100	0.4800	5.00	.0000	.0000	23.44	18.48	11
3.2800	1.5600	0.9500	0.6100	6.30	.0030	.0000	26.48	17.68	12
3.5200	0.9300	0.7800	0.1500	6.10	.0020	.0000	19.44	18.08	13
1.0000	0.4200	0.2700	0.1500	3.13	.0020	.0200	7.01	6.56	14
2.8115	0.8418	0.4955	0.3463	5.59	.0013	.0023	23.14	19.65	15

Odor, offensive.—— The sewage was collected as it entered the settling tank.

Chemical Examination of Effluent from the Underdrain of the Leicester Filter Beds.

[Parts per 100,000.]

Number.	Date of Collection.	Appearance.			Odor.		Residue on Evaporation.
		Turbidity.	Sediment.	Color.	Cold.	Hot.	
	1896.						
18219	Dec. 31	Decided, milky.	Cons., dark.	0.12	Offensive.	Offensive.	65.40
	1897.						
18386	Jan. 27	Decided.	Cons., rusty.	2.00	Offensive.	Offensive.	28.20
18942	Apr. 1	Distinct.	Slight.	0.80	Distinctly disagreeable.	Decidedly disagreeable.	68.10
19047	Apr. 14	Decided.	Cons.	–	Decidedly disagreeable.	Decidedly disagreeable.	40.00
19247	May 12	Distinct, cons.	Cons.	0.70	Decidedly disagreeable.	Decidedly musty and disagreeable.	43.20
19432	June 9	Distinct, milky.	V. slight.	0.60	Decidedly disagreeable.	Offensive.	58.70
19792	July 14	Distinct, black.	Cons., black.	–	Offensive.	Offensive.	39.70
20076	Aug. 11	Distinct.	Heavy, red.	1.15	Distinctly disagreeable.	Distinctly disagreeable.	26.80
20796	Oct. 13	Distinct.	Cons.	–	Offensive.	Offensive.	51.80
21119	Nov. 10	Decided.	Slight.	–	V. offensive.	V. offensive.	58.30
Av.*	....	....	....	–	....	....	47.35

Chemical Examination of Effluent from the Underdrain of the Leicester Filter Beds — Concluded.

[Parts per 100,000.]

Number.	Ammonia.		Chlorine.	Nitrogen as		Oxygen Consumed.	Hardness.	Iron.
	Free.	Albuminoid.		Nitrates.	Nitrites.			
18219	2.6400	0.4200	6.15	.0020	.0008	21.80	8.1	0.0740
18386	0.0992	0.0276	3.24	.0300	.0050	2.26	12.3	2.0000
18942	1.3600	0.1960	7.90	.0150	.0090	15.04	11.8	0.0800
19047	1.1200	0.1920	3.87	.0000	.0000	6.56	10.4	0.1600
19247	1.9200	0.1840	5.47	.0000	.0001	4.48	12.4	0.1100
19432	1.9200	0.1500	6.45	.1750	.1500	8.72	10.6	0.0330
19792	1.9200	0.1580	5.76	.0000	.0000	4.75	8.4	0.0900
20076	0.4880	0.0600	3.68	.1750	.0130	1.86	7.7	2.4000
20796	2.4000	0.7200	5.80	.0030	.0000	10.32	15.6	0.0800
21119	2.2000	0.2020	6.72	.0100	.0015	10.40	18.0	0.2300
Av.*	1.6475	0.2351	5.46	.0447	.0194	8.38	11.6	0.5708

* Where more than one sample was collected in a month, the mean analysis for that month has been used in making the average.

The samples were collected from the underdrain at the point where it discharges into the brook.

Chemical Examination of Water from the Brook above the Leicester Filter Beds.

[Parts per 100,000.]

Number.	Date of Collection.	Appearance.			Residue on Evaporation.		Ammonia.				Chlorine.	Nitrogen as		Oxygen Consumed.	Hardness.
		Turbidity.	Sediment.	Color.	Total.	Loss on Ignition.	Free.	Albuminoid. Total.	Albuminoid. Dissolved.	Albuminoid. Suspended.		Nitrates.	Nitrites.		
	1897.														
19793	July 14	Slight.	Cons.	.40	3.85	1.60	.0048	.0206	.0148	.0058	.25	.0040	.0001	.62	1.4
20545	Sept. 16	Distinct.	Cons.	.44	3.70	1.80	.0018	.0214	.0178	.0036	.42	.0030	.0000	.49	1.3

Odor, distinctly vegetable. —— The samples were collected from the brook, above the point where effluent from the filter beds enters the stream.

Chemical Examination of Water from the Brook below the Leicester Filter Beds.

[Parts per 100,000.]

Number.	Date of Collection.	Appearance.			Residue on Evaporation.		Ammonia.				Chlorine.	Nitrogen as		Oxygen Consumed.	Hardness.
		Turbidity.	Sediment.	Color.	Total.	Loss on Ignition.	Free.	Albuminoid. Total.	Albuminoid. Dissolved.	Albuminoid. Suspended.		Nitrates.	Nitrites.		
	1897.														
19794	July 14	Slight.	Cons.	.72	7.10	2.55	.0040	.0308	.0248	.0060	.70	.0250	.0003	.95	2.1
20077	Aug. 11	Slight.	Cons.	.48	5.55	2.20	.0152	.0308	.0232	.0076	.80	.0200	.0002	.73	1.6
20546	Sept. 16	V. slight.	Slight.	.45	3.95	1.40	.0068	.0228	.0190	.0038	.54	.0030	.0001	.52	1.6
Av...	....	....	....	.55	5.53	2.05	.0087	.0281	.0223	.0058	.	.0160	.0002	.73	1.8

Odor, distinctly vegetable and musty. —— The samples were collected from the brook below the point where the effluent from the filter beds enters the stream.

Sewage Disposal at Leicester Poor Farm.

The Leicester Poor Farm is situated on the watershed of Kettle Brook, one of the sources of water supply of the city of Worcester. Filter beds for the purification of the sewage from the buildings were constructed in 1895. The filtration area is 50 feet square and is divided into four beds. The filtering material is composed of selected sand and gravel of varying degrees of fineness, the finest material being at the surface. Sewage flows directly from the buildings to the beds by gravity and is distributed by means of shallow wooden carriers. The effluent from the beds flows into one of the branches of Kettle Brook.

Chemical Examination of Effluent from the Underdrain

[Parts per 100,000.]

	Number.	Date of Collection.	Appearance.			Odor.		Residue on Evaporation.
			Turbidity.	Sediment.	Color.	Cold.	Hot.	
		1895.						
1	15172	Sept. 16	Decided, brown & clayey.	Heavy, brown & earthy.	.35	Distinctly musty.	Decidedly musty.	21.00
2	15441	Oct. 29	Slight.	Cons., earthy.	.20	Faintly vegetable.	Faintly vegetable and mouldy.	18.40
		1896.						
3	16085	Feb. 18	Slight.	Cons., earthy.	.02	Faintly musty.	Distinctly musty.	15.85
4	16275	Mar. 17	Decided, clayey.	Cons., earthy.	.02	Distinctly earthy.	Distinctly earthy and musty.	16.90
5	16457	Apr. 21	Slight.	Slight.	.02	Faintly earthy.	Distinctly mouldy.	22.60
6	16625	May 19	Slight.	Cons., earthy.	.03	Faintly musty.	Distinctly musty.	24.95
7	16812	June 16	V. slight.	Slight.	.00	None.	Distinctly woody.	25.30
8	17036	July 21	Distinct, green.	Cons., earthy.	.04	Faintly unpleasant.	Distinctly unpleasant.	23.90
9	17241	Aug. 18	Slight.	Cons.	.02	Distinctly vegetable and sweetish.	Distinctly sweet.	25.80
10	17462	Sept. 14	V. slight.	Slight, earthy.	.04	None.	Faintly musty.	23.50
11	17686	Oct. 20	V. slight.	Cons., green.	.03	Distinctly vegetable.	Distinctly vegetable.	19.10
12	17889	Nov. 17	None.	Cons., sandy.	.00	None.	None.	19.10
13	18135	Dec. 15	None.	Cons., sandy.	.00	Faintly mouldy.	Faintly mouldy.	18.80
14	Av.	....	....	....	.06	....	....	21.17
		1897.						
15	18286	Jan. 18	V. slight.	Cons.	.05	Faintly musty.	Decidedly musty.	18.40
16	18520	Feb. 16	V. slight.	Cons.	.03	Faintly unpleasant.	Distinctly musty and unpleasant.	16.30
17	18786	Mar. 15	V. slight.	Cons.	.00	Distinctly musty.	Distinctly musty and unpleasant.	17.10
18	19078	April 20	None.	Cons.	.02	Faintly mouldy and unpleasant.	Distinctly musty.	19.00
19	19273	May 18	Slight.	Cons.	.02	Faintly musty.	Decidedly musty.	17.50
20	19472	June 15	None.	Cons.	.02	Faintly musty.	Distinctly musty.	22.50
21	19841	July 20	V. slight.	Slight.	.02	None.	Faintly mouldy.	22.80
22	20133	Aug. 17	V. slight.	V. slight.	.02	Distinctly mouldy.	Faintly mouldy.	17.60
23	20592	Sept. 21	Slight.	Cons.	.05	None.	Faintly musty.	17.30
24	20892	Oct. 19	V. slight.	Cons.	.48	Faintly musty.	Distinctly musty.	20.60
25	21254	Nov. 16	Slight.	Heavy.	.05	Faintly musty and earthy.	Strongly musty and earthy.	18.50
26	21653	Dec. 23	V. slight.	Cons.	.11	Faintly mouldy.	Distinctly mouldy and earthy.	15.30
27	Av.	....	....	....	.07	....	....	18.57

of the Filter Beds at the Leicester Poor Farm.

[Parts per 100,000.]

Ammonia.		Chlorine.	Nitrogen as		Oxygen Consumed.	Hardness.	Iron.	
Free.	Albuminoid.		Nitrates.	Nitrites.				
.1040	.0570	3.05	0.1850	.0180	1.25	6.7	.2900	1
.0060	.0072	3.00	0.4500	.0040	0.34	5.6	.0100	2
.0314	.0158	2.23	0.5250	.0040	0.09	4.7	–	3
.0332	.0194	2.35	0.3900	.0019	0.11	5.3	–	4
.0416	.0106	2.58	1.7600	.0220	0.19	7.1	–	5
.0018	.0070	2.74	1.3250	.0005	0.09	7.6	–	6
.0032	.0056	2.51	0.2250	.0019	0.07	8.0	–	7
.0004	.0134	2.83	0.8200	.0003	0.08	7.7	.0350	8
.0000	.0094	3.23	0.1400	.0003	0.19	7.4	.0080	9
.0008	.0058	2.81	1.0000	.0000	0.10	7.4	.0070	10
.0026	.0058	2.28	1.0000	.0008	0.13	6.1	.0060	11
.0002	.0076	2.27	0.1150	.0001	0.07	6.3	.0080	12
.0084	.0086	2.18	1.0000	.0004	0.13	6.6	.0050	13
.0180	.0133	2.62	0.6873	.0042	0.22	6.7	.0461	14
.5600	.0170	2.11	0.6250	.0029	0.23	4.2	.0170	15
.3660	.0250	2.00	0.4650	.0024	0.12	4.4	.0170	16
.1200	.0110	1.84	0.7000	.0028	0.03	5.6	.0180	17
.0568	.0116	1.84	0.7700	.0012	0.11	5.9	.0180	18
.0096	.0080	1.80	0.7000	.0001	0.04	5.3	.0040	19
.0038	.0136	1.76	0.7500	.0002	0.18	6.3	.0130	20
.0020	.0076	2.08	0.5500	.0001	0.12	6.0	.0100	21
.0010	.0050	2.06	0.5250	.0000	0.09	4.9	.0030	22
.0004	.0204	1.80	0.4250	.0000	0.51	4.0	.0020	23
.0028	.0112	2.40	0.7800	.0000	0.32	5.7	.0090	24
.0748	.0418	2.28	0.8000	.0010	0.16	6.4	.0020	25
.2560	.0316	1.88	0.4200	.0010	0.18	4.2	.0040	26
.1211	.0170	1.99	0.6258	.0010	0.17	5.2	.0097	27

SEWAGE DISPOSAL

Chemical Examination of

[Parts per 100,000.]

	Number.	Date of Collection.	Residue on Evaporation.					
			Total Residue.			Loss on Ignition.		
			Total.	Dissolved.	Suspended.	Total.	Dissolved.	Suspended.
		1897.						
1	18320	Jan. 20	41.80	31.60	10.20	19.40	10.40	9.00
2	18488	Feb. 11	46.00	32.60	13.40	22.80	14.80	8.00
3	18756	Mar. 10	46.60	25.60	21.00	22.20	8.20	14.00
4	19050	Apr. 14	40.00	25.80	14.20	16.00	5.80	10.20
5	19242	May 12	48.00	31.80	16.20	23.00	10.80	12.20
6	19442	June 10	43.00	29.70	13.30	15.80	8.00	7.80
7	19799	July 14	48.00	33.40	14.60	20.40	9.00	11.40
8	20085	Aug. 11	46.00	29.80	16.20	21.20	7.10	14.10
9	20540	Sept. 15	121.20	51.40	69.80	81.20	15.00	66.20
10	20812	Oct. 14	65.40	43.60	21.80	35.40	17.60	17.80
11	21122	Nov. 10	44.40	30.40	14.00	19.80	7.60	12.20
12	21588	Dec. 16	32.40	26.60	5.80	13.40	8.70	4.70
13	Av.	....	51.90	32.69	19.21	25.88	10.25	15.63

Odor, offensive.—— The samples were collected from the separatiug tanks, and

AT MARLBOROUGH.

Sewage from Marlborough.

[Parts per 100,000.]

Ammonia.				Chlorine.	Nitrogen as		Oxygen Consumed.		
Free.	Albuminoid.				Nitrates.	Nitrites.	Unfiltered.	Filtered.	
	Total.	Dissolved.	Sus-pended.						
1.9680	0.5260	0.4100	0.1160	6.44	.0050	.0000	4.53	2.63	1
2.0800	0.6440	0.3440	0.3000	5.90	.0050	.0000	4.32	2.44	2
1.6000	0.4400	0.2420	0.1980	4.38	.0450	.0195	3.28	1.68	3
1.0400	0.3400	0.1720	0.1680	4.58	.1000	.1300	2.40	1.32	4
1.4400	0.5340	0.2560	0.2780	5.83	.0030	.0000	3.48	2.24	5
1.4400	0.4640	0.1610	0.3030	4.42	.0680	.0225	3.08	2.16	6
2.5200	0.5280	0.0240	0.5040	6.50	.0070	.0000	9.89	3.12	7
2.5600	0.6840	0.2080	0.4760	6.05	.0030	.0000	4.13	2.07	8
2.0000	0.8940	0.3980	0.4960	13.50	.0000	.0000	6.64	2.96	9
6.4000	1.5100	0.7100	0.8000	7.55	.0030	.0000	8.80	4.48	10
4.0400	0.9400	0.5300	0.4100	6.62	.0070	.0000	3.52	1.52	11
1.6400	0.5900	0.3800	0.2100	4.30	.6800	.0560	2.11	0.84	12
2.3940	0.6745	0.3196	0.3549	6.34	.0772	.0190	4.68	2.29	13

represent the sewage after a portion of the suspended matter has been separated from it.

Chemical Examination of Effluent from the Under-

[Parts per 100,000.]

	Number.	Date of Collection.	Appearance. Turbidity.	Appearance. Sediment.	Appearance. Color.	Odor. Cold.	Odor. Hot.
		1897.					
1	18321	Jan. 20	Slight, milky.	V. slight.	0.20	Distinctly disagreeable.	Distinctly disagreeable.
2	18322	Jan. 20	Slight, milky.	V. slight.	0.30	Distinctly disagreeable.	Distinctly musty and disagreeable.
3	18489	Feb. 11	Distinctly milky.	Cons.	0.20	Distinctly disagreeable.	Decidedly disagreeable.
4	18490	Feb. 11	Slight, milky.	Slight.	0.05	Distinctly musty and unpleasant.	Distinctly musty.
5	18757	Mar. 10	Distinct, scum.	Cons., iron.	0.35	Distinctly musty and disagreeable.	Decidedly musty and disagreeable.
6	18758	Mar. 10	Distinct.	Slight.	0.35	Distinctly musty and disagreeable.	Distinctly musty and disagreeable.
7	19051	Apr. 14	Decided.	Cons.	1.50	Decidedly musty and disagreeable.	Decidedly musty and disagreeable.
8	19052	Apr. 14	Distinct.	Cons.	0.35	Decidedly musty and disagreeable.	Decidedly musty and disagreeable.
9	19243	May 12	Distinct.	Cons.	1.10	Distinctly musty and unpleasant.	Decidedly musty and disagreeable.
10	19244	May 12	Distinct.	Cons.	0.90	Distinctly musty and unpleasant.	Decidedly musty and disagreeable.
11	19443	June 10	Distinct.	Heavy.	0.32	Distinctly musty and disagreeable.	Decidedly musty and disagreeable.
12	19444	June 10	Slight.	Slight.	0.18	Distinctly musty and disagreeable.	Decidedly musty and disagreeable.
13	19800	July 14	Slight.	V. slight.	0.30	Distinctly musty and unpleasant.	Distinctly musty and disagreeable.
14	19801	July 14	Slight.	Slight.	0.28	Distinctly musty and unpleasant.	Distinctly musty and disagreeable.
15	20086	Aug. 11	Distinct.	Cons., iron.	1.20	Decidedly musty.	Decidedly musty.
16	20087	Aug. 11	Distinct.	Cons.	0.45	Decidedly musty and disagreeable.	Decidedly musty and disagreeable.
17	20541	Sept. 15	V. slight, milky.	V. slight.	0.18	Distinctly musty and disagreeable.	Distinctly musty and disagreeable.
18	20542	Sept. 15	None.	V. slight.	0.22	Distinctly musty and disagreeable.	Distinctly musty and disagreeable.
19	20813	Oct. 14	None.	V. slight.	0.12	Distinctly disagreeable.	Distinctly disagreeable and faintly musty.
20	20814	Oct. 14	Slight, milky.	V. slight.	0.40	Decidedly musty and disagreeable.	Decidedly musty and disagreeable.
21	21123	Nov. 10	Slight.	Cons.	0.11	Distinctly mouldy.	Strongly mouldy and musty.
22	21124	Nov. 10	Decided.	Heavy, iron.	0.11	Decidedly musty.	Strongly musty.
23	21589	Dec. 16	Decided.	Cons.	0.40	Decidedly disagreeable.	Strongly musty and disagreeable.
24	21590	Dec. 16	Decided.	Cons.	0.19	Strongly musty and disagreeable.	Offensive.
25	Av.*	....	....	....	0.41	....	....

* Where more than one sample was collected in a month, the

drains of the Marlborough Filter Beds.

[Parts per 100,000.]

Residue on Evaporation.	Ammonia.		Chlorine.	Nitrogen as		Oxygen Consumed.	Hardness.	Iron.	
	Free.	Albu-minoid.		Nitrates.	Nitrites.				
25.70	0.7200	0.0480	4.98	0.8000	0.0095	.30	4.9	.0400	1
25.10	0.5200	0.0230	4.94	0.7000	0.0032	.23	5.1	.0520	2
20.80	0.8480	0.0720	4.36	0.3400	0.0130	.51	4.4	.0580	3
21.70	0.6400	0.0440	4.47	0.4000	0.0040	.27	5.0	.0200	4
20.50	0.8800	0.0600	4.07	0.3000	0.0100	.55	4.3	.1900	5
20.50	1.0400	0.0620	4.48	0.1500	0.0100	.40	5.1	.0500	6
21.70	0.9600	0.0520	3.80	0.3000	0.0120	.51	6.0	.4400	7
22.20	1.0400	0.0320	3.82	0.3500	0.0220	.38	6.3	.0650	8
23.20	0.9280	0.0400	5.16	0.1500	0.0250	.44	8.1	.3000	9
26.80	0.9600	0.0240	4.73	0.5250	0.0100	.29	8.1	.2000	10
26.00	0.7600	0.0390	5.00	0.2500	0.0005	.38	6.1	.2800	11
29.80	0.7600	0.0370	4.64	0.6500	0.0220	.92	7.1	.0450	12
32.40	0.4800	0.0170	6.40	1.0000	0.0012	.30	10.2	.0650	13
35.00	0.5160	0.0240	6.70	1.1500	0.0150	.50	9.9	.0600	14
24.30	0.6000	0.0310	5.46	0.2800	0.0025	.34	6.9	.3400	15
27.40	0.4400	0.0320	5.65	0.4750	0.0175	.36	8.0	.1150	16
34.10	0.4080	0.0072	7.20	0.5750	0.0125	.42	8.7	.0280	17
33.10	0.4400	0.0220	6.60	0.5500	0.0090	.26	8.6	.0280	18
31.60	0.9600	0.1040	7.06	0.5000	0.0056	.31	8.0	.0240	19
29.85	1.0400	0.1040	6.92	0.2500	0.0300	.54	7.6	.0475	20
36.00	0.6400	0.0372	7.28	1.3250	0.0180	.27	11.7	.0200	21
58.40	0.9040	0.0580	22.40	0.6000	0.0300	.60	12.9	.2400	22
24.70	0.8675	0.0520	6.45	0.4700	0.0360	.44	6.4	.0950	23
25.80	0.9195	0.0420	5.45	0.4900	0.0440	.42	7.4	.1400	24
28.19	0.7613	0.0443	6.17	0.5242	0.0151	.41	7.4	.1226	25

mean analysis for that month has been used in making the average.

Chemical Examination of Water from the Brook into which the

[Parts per 100,000.]

	Number.	Date of Collection.	Appearance.			Odor.		Residue on Evaporation.	
			Turbidity.	Sediment.	Color.	Cold.	Hot.	Total.	Loss on Ignition.
		1897.							
1	18323	Jan. 20	V. slight.	Slight.	0.25	Distinctly unpleasant.	Distinctly musty and unpleasant.	18.50	6.50
2	18491	Feb. 11	Slight.	Cons.	0.33	Distinctly unpleasant.	Distinctly unpleasant.	13.50	4.70
3	18759	Mar. 10	Distinct.	Cons.	0.60	Distinctly musty and unpleasant.	Distinctly musty.	8.00	3.10
4	19053	April 14	Distinct.	Cons.	0.40	Distinctly musty and disagreeable.	Distinctly musty and disagreeable.	12.50	2.70
5	19245	May 12	Slight.	Cons.	0.70	Distinctly musty and unpleasant.	Distinctly musty and unpleasant.	13.00	4.30
6	19445	June 10	V. slight.	Cons.	1.10	Faintly musty and disagreeable.	Distinctly musty and disagreeable.	12.90	4.40
7	19802	July 14	Slight.	Cons.	0.98	Distinctly musty.	Distinctly musty and unpleasant.	18.10	4.80
8	20088	Aug. 11	V. slight.	Slight.	0.19	Distinctly musty.	Distinctly musty and disagreeable.	18.20	5.10
9	20543	Sept. 15	None.	Slight.	0.15	Faintly vegetable and musty.	Distinctly musty.	28.65	7.65
10	20815	Oct. 14	None.	Slight.	0.10	Distinctly unpleasant.	Distinctly musty and unpleasant.	29.30	8.85
11	21125	Nov. 10	V. slight.	Cons.	0.68	Faintly vegetable.	Distinctly vegetable and earthy.	20.45	5.25
12	21591	Dec. 16	Slight.	Cons.	0.50	Distinctly musty and unpleasant.	Strongly musty and unpleasant.	18.30	6.25
13	Av...	....	....	....	0.50	....	....	17.62	5.30

The samples were collected from the brook at the road crossing below the

Sewage Disposal

Chemical Examination of

[Parts per 100,000.]

	Number.	Date of Collection.	Residue on Evaporation.					
			Total Residue.			Loss on Ignition.		
			Total.	Dissolved.	Suspended.	Total.	Dissolved.	Suspended.
		1897.						
1	18314	Jan. 20	63.40	52.80	10.60	26.60	16.60	10.00
2	18761	Mar. 11	102.20	91.00	11.20	50.40	40.00	10.40
3	19234	May 12	403.60	387.20	16.40	72.60	72.50	0.10
4	19808	July 15	38.40	33.00	5.40	23.60	19.20	4.40
5	20547	Sept. 16	21.60	16.30	5.30	10.20	5.10	5.10
6	21316	Nov. 22	178.60	166.00	12.60	50.30	44.50	5.80
7	Av.	....	134.63	124.38	10.25	38.95	32.98	5.97

Odor, offensive.—— The samples were collected

Effluent from the Marlborough Sewage Filter Beds is discharged.

[Parts per 100,000.]

Ammonia.				Chlorine.	Nitrogen as		Oxygen Consumed.	Hardness.	
	Albuminoid.								
Free.	Total.	Dis-solved.	Sus-pended.		Nitrates.	Nitrites.			
0.8000	.0360	.0300	.0060	3.30	.5600	.0080	.32	4.3	1
0.5040	.0360	.0280	.0080	2.58	.3000	.0070	.42	3.4	2
0.3920	.0440	.0340	.0100	1.72	.1250	.0030	.54	2.5	3
0.4960	.0420	.0280	.0140	2.75	.2000	.0120	.50	5.1	4
0.4080	.0290	.0220	.0070	2.38	.1750	.0050	.63	4.4	5
0.2800	.0440	.0370	.0070	1.47	.2250	.0125	.34	3.1	6
0.3120	.0400	.0270	.0130	3.60	.2400	.0130	.84	4.7	7
0.3200	.0240	.0210	.0030	4.49	.2200	.0180	.33	6.6	8
0.3360	.0370	.0200	.0170	5.68	.5250	.0400	.49	6.6	9
0.4000	.1020	–	–	5.43	.5700	.0400	.30	8.4	10
2.6400	.0276	.0242	.0034	4.81	.4750	.0100	.57	5.1	11
0.2168	.0352	.0264	.0088	3.20	.4300	.0160	.52	5.0	12
0.5921	.0359	.0271	.0088	3.45	.3371	.0154	.48	4.9	13

filter beds and below where the effluent from the filter beds enters the stream.

AT MEDFIELD.

Sewage from Medfield.

[Parts per 100,000.]

Ammonia.				Chlorine.	Nitrogen as		Oxygen Consumed.		
	Albuminoid.								
Free.	Total.	Dissolved.	Sus-pended.		Nitrates.	Nitrites.	Unfiltered.	Filtered.	
2.0000	0.6600	0.5000	0.1600	12.56	–	.0120	15.77	12.26	1
2.4800	1.6400	1.4700	0.1700	4.62	.0000	.0000	19.76	17.04	2
1.4400	0.6760	0.4900	0.1860	3.56	.0050	.0125	9.84	7.76	3
1.6000	1.6500	1.5140	0.1360	2.35	.0030	.0000	5.01	3.72	4
0.5560	0.5440	0.4960	0.0480	1.40	.0020	.0000	2.64	1.12	5
2.2800	1.2200	1.0200	0.2000	3.80	.0030	.0090	10.80	9.20	6
1.7260	1.0650	0.9150	0.1500	4.71	.0026	.0056	10.64	8.52	7

as the sewage flowed upon the filter beds.

Chemical Examination of Water from a Spring below

[Parts per 100,000.]

	Number.	Date of Collection.	Appearance. Turbidity.	Appearance. Sediment.	Appearance. Color.	Odor. Cold.	Odor. Hot.	Residue on Evaporation.
		1897.						
1	18315	Jan. 20	V. slight.	V. slight.	0.25	Faintly unpleasant.	Faintly unpleasant.	5.90
2	18762	Mar. 11	None.	V. slight.	0.05	None.	Faintly mouldy.	5.50
3	19235	May 12	Distinct.	Slight.	0.35	Distinctly unpleasant.	Distinctly unpleasant.	5.20
4	19809	July 15	Slight.	Cons.	1.12	Distinctly vegetable and mouldy.	Distinctly vegetable.	8.60
5	20548	Sept. 16	Distinct.	Cons.	1.00	Distinctly disagreeable.	Distinctly unpleasant.	5.30
6	21317	Nov. 22	Slight.	Cons.	0.84	Mouldy.	Distinctly mouldy and offensive.	11.90
7	Av.	....	....	....	0.60	....	....	7.07

The samples were collected from the spring which is located north of the filter beds and a little over direction of this spring.

Sewage Disposal

Chemical Examination of

[Parts per 100,000.]

	Number.	Date of Collection.	Residue on Evaporation. Total Residue. Total.	Total Residue. Dis-solved.	Total Residue. Sus-pended.	Loss on Ignition. Total.	Loss on Ignition. Dis-solved.	Loss on Ignition. Sus-pended.
		1897.						
1	18387	Jan. 27	27.80	26.80	1.00	9.60	9.50	0.10
2	18663	Feb. 25	31.00	25.20	5.80	7.40	7.00	0.40
3	18813	Mar. 18	23.40	22.40	1.00	8.70	8.10	0.60
4	19061	Apr. 15	25.80	25.00	0.80	10.20	10.00	0.20
5	19254	May 13	25.60	23.60	2.00	6.20	4.80	1.40
6	19439	June 10	24.70	23.60	1.10	4.80	4.10	0.70
7	19806	July 15	27.80	25.30	2.50	7.00	5.10	1.90
8	20524	Sept. 15	29.20	27.20	2.00	9.80	7.80	2.00
9	20817	Oct. 15	28.40	25.80	2.60	9.40	7.30	2.10
10	21228	Nov. 11	29.20	25.50	3.70	10.00	7.30	2.70
11	21593	Dec. 16	24.00	21.80	2.20	6.50	5.50	1.00
12	Av.	....	26.99	24.75	2.24	8.14	6.95	1.19

Odor, from January to June, musty and disagreeable, and for the remainder of the

the Filtration Area of the Medfield Sewerage System.

[Parts per 100,000.]

Ammonia.		Chlorine.	Nitrogen as		Oxygen Consumed.	Hardness.	Iron.	
Free.	Albuminoid.		Nitrates.	Nitrites.				
.0028	.0036	0.46	.0400	.0006	.09	1.6	.0320	1
.0014	.0058	0.50	.1400	.0001	.14	1.6	.0080	2
.0006	.0120	0.55	.0150	.0002	.27	2.2	.0230	3
.0040	.0664	0.90	.0000	.0001	.58	2.2	.2250	4
.0020	.0310	0.54	.0000	.0000	.54	2.1	.0900	5
.0214	.0454	1.89	.0030	.0001	.40	2.1	.1750	6
.0054	.0274	0.81	.0330	.0002	.34	2.0	.0922	7

260 feet from the edge of the nearest bed. The ground where the filter beds are located slopes in the

at Natick.

Sewage from Natick.

[Parts per 100,000.]

Ammonia.				Chlorine.	Nitrogen as		Oxygen Consumed.		
	Albuminoid.								
Free.	Total.	Dissolved.	Suspended.		Nitrates.	Nitrites.	Unfiltered.	Filtered.	
0.2720	0.0640	0.0504	0.0136	3.54	.5000	.0135	0.74	0.69	1
0.2520	0.0600	0.0230	0.0370	3.32	.5250	.0165	0.80	0.48	2
0.2880	0.0400	0.0264	0.0136	3.42	.5250	.0175	0.56	0.49	3
0.1400	0.0400	0.0270	0.0130	3.10	.6200	.0160	0.39	0.32	4
0.4080	0.1090	0.0340	0.0750	3.84	.3500	.0160	0.62	0.40	5
0.4320	0.0750	0.0340	0.0410	3.38	.1600	.0250	0.72	0.64	6
0.6080	0.1300	0.0760	0.0540	4.85	.0020	.0000	1.75	1.37	7
0.7200	0.1820	0.1120	0.0700	5.40	.0000	.0000	1.76	1.20	8
1.1200	0.3300	0.2700	0.0600	4.80	.0100	.0001	2.80	2.21	9
1.4000	0.3800	0.1800	0.2000	4.45	.0020	.0003	2.48	1.52	10
0.8400	0.3900	0.3000	0.0900	3.10	.4500	.0880	0.70	0.62	11
0.5891	0.1636	0.1030	0.0606	3.93	.2858	.0175	1.21	0.90	12

year, offensive. —— The sewage was collected as it flowed out upon the filter beds.

Chemical Examination of Effluent from

[Parts per 100,000.]

	Number.	Date of Collection.	Appearance.			Odor.		Residue on Evaporation.
			Turbidity.	Sediment.	Color.	Cold.	Hot.	
		1897.						
1	18388	Jan. 27	None.	Slight, sandy.	0.00	Faintly musty.	Distinctly musty and unpleasant.	24.50
2	18664	Feb. 25	V. slight.	V. slight.	0.07	Distinctly musty.	Faintly musty.	21.00
3	18814	Mar. 18	None.	None.	0.05	None.	Distinctly unpleasant.	17.90
4	19062	April 15	None.	V. slight.	0.05	None.	Faintly mouldy.	20.20
5	19255	May 13	None.	V. slight.	0.40	Faintly unpleasant.	Distinctly mouldy.	16.10
6	19440	June 10	None.	V. slight.	0.30	V. faintly unpleasant.	None.	21.80
7	19807	July 15	V. slight.	V. slight.	0.07	Faintly musty.	Distinctly musty.	21.80
8	20095	Aug. 12	V. slight.	Slight.	0.03	Distinctly mouldy.	Distinctly mouldy.	23.10
9	20525	Sept. 15	V. slight.	Slight.	0.43	Distinctly musty.	Faintly musty.	13.20
10	20818	Oct. 15	None.	V. slight.	0.10	Distinctly disagreeable.	Distinctly musty and disagreeable.	19.40
11	21229	Nov. 11.	V. slight.	Cons.	0.12	Faintly musty.	Distinctly musty.	20.50
12	21594	Dec. 16.	V. slight.	Cons.	1.00	Distinctly musty.	Distinctly musty.	16.70
13	Av.	....	....	....	0.22	....	....	19.68

The samples were collected from the underdrain at the

Sewage Disposal at Spencer.

Population in 1895, 7,614. A system for the disposal of the sewage of the town of Spencer by intermittent filtration through sand was put in operation in the fall of 1897. The filtration area is situated on the easterly side of the Quaboag River, about midway between the villages of Spencer and East Brookfield. The area prepared for the filtration of sewage contains twelve beds, having an aggregate area of 9.3 acres, exclusive of embankments, all of which

the Underdrain of the Natick Filter Beds.

[Parts per 100,000.]

Ammonia.		Chlorine.	Nitrogen as		Oxygen Consumed.	Hardness.	Iron.	
Free.	Albuminoid.		Nitrates.	Nitrites.				
.0400	.0086	3.20	.5500	.0050	.08	6.9	.0050	1
.0192	.0112	3.05	.7500	.0025	.25	7.7	.0020	2
.0126	.0058	2.80	.5800	.0015	.15	5.9	.0100	3
.0022	.0068	2.70	.6250	.0005	.14	6.4	.0000	4
.0032	.0086	2.94	.5000	.0002	.35	5.6	.0030	5
.0032	.0100	3.30	.4250	.0000	.32	7.0	.0100	6
.0020	.0086	4.40	.3750	.0008	.20	7.7	.0010	7
.0006	.0094	5.08	.2500	.0002	.13	7.7	.0020	8
.0200	.0146	2.80	.1600	.0007	.41	3.8	.0000	9
.2400	.0380	4.20	.3500	.0960	.39	7.0	.0040	10
.0368	.0176	3.98	.3450	.0020	.15	7.7	.0010	11
.0152	.0212	3.08	.4300	.0014	.82	5.0	.0120	21
.0329	.0134	3.46	.4450	.0092	.28	6.5	.0042	13

point where it discharges into Bannister Brook.

was prepared by the removal of all the soil and sub-soil. Some of the beds in which the finest material is found are underdrained, the underdrains discharging into the Quaboag River, but most of the beds are composed of such coarse material that no underdrains were considered necessary.

A further description of these works, together with analyses of sewage and effluent, will be given in a subsequent report.

FOOD AND DRUG INSPECTION.

FOOD AND DRUG INSPECTION.

The work of food and drug inspection performed by the State Board of Health is conducted under the provisions of an act of 1882, with subsequent amendments, authorizing the Board to expend annually a sum not exceeding $11,500 for the purpose of enforcing the laws relating to adulteration, it being also provided that three-fifths of this sum shall be expended in enforcing the laws relating to milk and milk products.

The operations of the Board, under the provisions of this act, for the year ending Sept. 30, 1897, are detailed in the following report.

The following persons comprised the force employed by the Board during the year: —

Dr. Charles P. Worcester,	*Analyst.*
Prof. Charles A. Goessmann,	*Analyst.*
Mr. Albert E. Leach,	*Assistant Analyst.*
John H. Terry,	*Inspector.*
John F. McCaffrey,	*Inspector.*
Horace F. Davis,	*Inspector.*
Thomas O. Allen,	*Inspector.*

The whole number of samples of food and drugs (including milk) examined during the year was 10,680, or 2,353 more than the number examined in the year ending Sept. 30, 1896, and 4,374 more than the average annual number examined in the ten years from Sept. 30, 1886, to Sept. 30, 1896.

The whole number examined since the beginning of operations in this department in 1883 was 86,793.

The following summary embraces the work done during the year: —

Number of samples of milk examined,	6,046
Number of samples above standard,	4,150
Number of samples below standard,	1,896
Percentage of adulteration or deficiency,	31.3
Number of samples of other kinds of food (not milk),	3,944
Number of samples above standard,	3,438
Number of samples below standard,	506
Percentage of adulteration,	12.8
Number of samples of drugs examined,	690
Number of samples of good quality,	442
Number of samples adulterated, as defined by the statutes,	248
Percentage of adulteration,	35.9
Total number of samples of food and drugs examined,	10,680
Total number found to be of good quality,	8,030
Total number not conforming to the statutes,	2,650
Percentage of adulteration,	24.8

It should not be inferred from an examination of these figures and those which are presented in the following tables that they represent the actual condition of the food supply of Massachusetts with reference to adulteration. As was stated in the last report of the Board, the experience of the Board enables it, first, to exercise a careful selection of such articles, mainly, as are liable to adulteration; secondly, to obtain such articles in those seasons of the year when their adulteration is most common; and third, to pay special attention to new forms of adulteration which are constantly appearing as fast as the fraud and ingenuity of the professional adulterator present them to the public.

The following table presents a summary of the work done during the entire period, from the beginning of operations under the food and drug acts in 1883 to the close of the year ending Sept. 30, 1897: —

STATISTICAL SUMMARY.

FOOD AND DRUG INSPECTION (1883–97).

SUMMARY.	YEARS.							
	1883.	1884.	1885.	1886.	1887.	1888.	1889.	1890.
Number of samples of milk examined,	218	1,123	2,219	2,085	3,081	2,825	3,219	3,236
Number of samples above standard,	35	347	1,297	1,323	1,900	1,705	1,971	1,858
Number of samples below standard,	183	776	922	762	1,181	1,120	1,248	1,378
Percentage of adulteration,	83.9	69.1	41.7	36.5	38.3	39.6	38.7	42.6
Number of samples of other kinds of food (not milk),	477	839	1,552	1,353	1,789	2,079	1,635	2,349
Number of samples of good quality,	328	432	883	863	1,263	1,680	1,242	1,913
Number of samples adulterated, as defined by the statutes,	149	407	669	490	556	399	393	436
Percentage of adulteration,	31.2	48.5	43.1	36.2	29.4	19.2	24.0	18.6
Number of samples of drugs examined,	603	682	1,007	888	550	862	600	400
Number of samples of good quality,	357	431	571	463	400	634	503	325
Number of samples adulterated, as defined by the statutes,	246	251	436	425	150	228	97	75
Percentage of adulteration,	40.8	36.8	43.3	47.8	27.3	26.4	16.2	18.7
Total examinations of food and drugs,	1,298	2,644	4,778	4,326	5,420	5,766	5,454	5,985
Total examinations of good quality,	720	1,210	2,751	2,649	3,563	4,019	3,716	4,096
Total examinations not conforming to the statutes,	578	1,434	2,027	1,677	1,857	1,747	1,738	1,889
Percentage of adulteration,	44.5	54.2	42.7	38.7	34.3	30.3	31.9	31.5
Expense of collection, examination and prosecution,	$2,931 56	$5,529 60	$8,557 43	$8,025 34	$8,803 62	$8,915 41	$10,356 28	$10,013 04
Expense of collection, examination and prosecution, per sample,	2 26	2 09	1 79	1 85	1 62	1 54	1 89	1 67

FOOD AND DRUG INSPECTION (1883-97) — *Concluded.*

SUMMARY.	Years.							Totals.
	1891.	1892.	1893.	1894.	1895.	1896.	1897.	
Number of samples of milk examined,	2,726	3,271	3,073	3,551	3,794	4,484	6,046	44,951
Number of samples above standard,	1,629	1,757	1,545	1,794	1,905	2,904	4,150	26,120
Number of samples below standard,	1,097	1,514	1,528	1,757	1,889	1,580	1,896	18,831
Percentage of adulteration,	40.2	46.3	49.7	49.5	49.8	35.2	31.3	41.9
Number of samples of other kinds of food examined (not milk),	2,144	2,441	3,009	2,836	2,971	3,368	3,944	32,786
Number of samples of good quality,	1,577	2,042	2,637	2,566	2,379	2,978	3,438	26,221
Number of samples adulterated, as defined by the statutes,	567	399	372	270	592	390	506	6,565
Percentage of adulteration,	26.4	16.3	12.3	9.5	19.9	11.6	12.8	20.0
Number of samples of drugs examined,	424	487	327	487	544	505	690	9,056
Number of samples of good quality,	352	312	228	324	212	251	442	5,805
Number of samples adulterated, as defined by the statutes,	72	175	99	163	332	254	248	3,251
Percentage of adulteration,	17.0	35.9	30.3	33.5	61.0	50.3	35.9	35.9
Total examinations of food and drugs,	5,294	6,199	6,409	6,874	7,309	8,357	10,680	86,793
Total examinations of good quality,	3,558	4,111	4,410	4,684	4,496	6,133	8,030	58,146
Total examinations not conforming to the statutes,	1,736	2,088	1,999	2,190	2,813	2,224	2,650	28,647
Percentage of adulteration,	32.8	33.7	31.2	31.9	38.5	26.6	24.8	33.0
Expense of collection, examination and prosecution,	$10,019 41	$11,180 30	$10,454 11	$10,364 64	$11,375 89	$10,921 61	$12,076 43	$139,524 67
Expense of collection, examination and prosecution, per sample,	1 89	1 80	1 63	1 52	1 56	1 23	1 13	1 61

From the foregoing table it appears that 86,793 samples of food and drugs have been collected by the inspectors of the Board and submitted to the analysts for examination during the fifteen years in which the statutes providing for this work have been in operation. The total cost of the work has been $139,524.67. Enough has already been said in previous reports to show that many times this sum have undoubtedly been saved to the consumers throughout the State.

The cost of collection and analysis per sample has also been reduced one-half. This expense in 1883 amounted to $2.26 per sample, but this amount has been reduced to 1.13 in 1897, a sum much less than that of any preceding year. Part of this saving is due to the concentration of the greater part of the work of analysis under one head at the State House laboratory.

In that portion of the analyst's report which relates to food inspection may be found a discussion of the subject of preservatives used in milk, and the methods of detecting them, especially with reference to the use of formalin. The examination of different brands of condensed milk and evaporated cream presented in the last report has been continued, and the results are given in this report.

A statement is also made of the results of an examination of wrappers composed of tin and lead foil used for containing articles of food, and stoppers of bottles used for containing beverages. In some countries the general laws relating to food inspection contain provisions for the inspection of all articles used in the preparation or wrapping of food, such as culinary utensils, tin and lead foil wrappers, stoppers, beer faucets, etc.

An examination was made during the year of jellies, preserves, jams, etc., with reference to their composition; and, while injurious substances were not found in them, it was found on examination that many of the fruit jellies were merely cheap imitations or substitutes for the articles indicated upon their labels.

Drugs.

The number of samples of drugs examined during the year (690) was larger than that of any year since 1888.

The principal articles found to be adulterated or below the standard strength were distilled water, subnitrate of bismuth, calx chlorata, citrate of iron and quinine, powdered opium, compound spirits of ether, whiskey, lemon juice, tincture of opium, white and red wine.

Notices.

The following lists present the names of the cities and towns to which notices were issued relating to the adulteration of different kinds of food and drugs: —

Cities and Towns to which Notices were sent on Account of Adulterated Milk.

Beverly,	2	Newton,	7
Boston,	4	Northborough,	2
Brockton,	7	Provincetown,	1
Brookline,	5	Quincy,	6
Cambridge,	4	Revere,	2
Charlton,	1	Salem,	3
Chelsea,	7	Salisbury Beach,	1
Dedham.	4	Somerville,	8
Everett,	2	Springfield,	6
Fall River,	14	Stoneham,	1
Fitchburg,	3	Stoughton,	6
Gloucester,	4	Taunton,	2
Haverhill,	2	Waltham,	6
Hull,	1	Watertown,	2
Hyde Park,	7	Westborough,	1
Lawrence,	1	Whitman.	2
Malden,	14	Winchester,	4
Marlborough,	1	Winthrop,	6
Medford,	4	Woburn,	4
Milford,	2	Worcester,	6
Natick,	3		
New Bedford,	1	Total,	170
Newburyport,	1		

Cities and Towns to which Notices were sent on Account of Adulterated Articles of Food other than Milk.

Boston,	30	Plymouth,	2
Brockton,	1	Quincy,	1
Cambridge,	6	Revere,	1
Chelsea,	3	Salem,	2
Everett,	2	Somerville,	2
Fall River,	8	Southbridge,	1
Hudson,	1	Springfield,	1
Hull,	1	Stoneham,	1
Lawrence,	3	Taunton,	6
Malden,	2	Wellesley,	1
Medford,	2	Westfield,	1
New Bedford,	7	Worcester,	4
North Adams,	11		
Northampton,	3	Total,	104
Palmer,	1		

Cities and Towns to which Notices were sent on Account of Adulterated Drugs.

Boston,	11	North Adams,	1
Cambridge,	1	Stoneham,	1
Dedham,	1	Stoughton,	1
Fitchburg,	1	Taunton,	1
Gloucester,	1		
Hyde Park,	1	Total,	21
Milford,	1		

Prosecutions.

In the reports of each of the last five years a condensed summary was presented, showing the number of prosecutions conducted in each year since the beginning of work under the food and drugs acts. The following table presents the same figures, with the addition of those for the year ending Sept. 30, 1897 : —

Number of Complaints entered in Court.

Year.	Food (not including Milk).	Drugs.	Milk.	Total.	Convictions.	Fines Imposed.
1883,	–	5	4	9	8	–‡
1884,	2	1	45	48	44	–‡
1885,*	50	1	68	119	103	–‡
1886,†	10	–	10	20	19	–‡
1887,	30	–	34	64	60	–‡
1888,	22	–	43	65	61	$2,042 00
1889,	74	–	66	140	124	3,889 00
1890,	78	–	24	102	96	3,919 00
1891,	96	5	49	150	135	2,668 00
1892,	52	12	72	136	123	3,661 70
1893,	26	3	67	96	92	2,476 00
1894,	14	–	76	90	77	2,625 00
1895,	13	11	68	92	86	2,895 30
1896,	7	–	68	75	74	2,812 20
1897,	13	1	51	65	64	2,756 60
Totals,	487	39	745	1,271	1,166	$29,744 80

* To May 1, 1886. † Four months only. ‡ No record kept.

Ratio of convictions to complaints, 91.7 per cent.

Note. — All complaints entered before May 1, 1886, were under the direction of the Board of Health, Lunacy and Charity, and all after that date were under the direction of the State Board of Health.

The following report was presented to the Legislature in January, 1898, in compliance with the provisions of the statutes: —

OFFICE OF THE STATE BOARD OF HEALTH,
STATE HOUSE, BOSTON, Jan. 1, 1898.

To the Honorable Senate and House of Representatives of the Commonwealth of Massachusetts in General Court assembled.

The following summary is made in compliance with the provisions of chapter 289, section 2, of the Acts of 1884, requiring the State Board of Health to "report annually to the Legislature the number of prosecutions made under chapter 263 of the Acts of 1882, and an itemized account of all money expended in carrying out the provisions thereof."

The whole number of prosecutions made by authority of the Board against offenders, under the provisions of the food and drug acts, for the year ending Sept. 30, 1897, was 65.

The cities and towns in which the articles were sold, and in respect to which complaints were entered in court, the character of the articles found to be adulterated, or fraudulently sold, the dates of the trials and their results, are presented in the following table: —

MILK AND MILK PRODUCTS.

For Fraudulent Sales of Milk.

PLACE.	DATE.	RESULT.
In Fall River,	Oct. 28, 1896,	Convicted.
Fall River,	Oct. 28, 1896,	"
Fall River,	Nov. 13, 1896,	"
Fall River,	Dec. 4, 1896,	"
Fall River,	July 14, 1897,	"
Fall River,	July 14, 1897,	"
Haverhill,*	Aug. 30, 1897,	"
Haverhill,*	Aug. 30, 1897,	"
Malden,	March 12, 1897,	"
Malden,	March 25, 1897,	"
Malden,	March 25, 1897,	"
Malden,	April 2, 1897,	"
Malden,	April 2, 1897,	"
Malden,	April 17, 1897,	"
Brockton,	May 4, 1897,	"
Brockton,	May 4, 1897,	"
Salem,	Oct. 13, 1896,	"
Salem,	Oct. 13, 1896,	"
Worcester,	Dec. 15, 1896,	"

* These two complaints were made against one person, one being for sale of milk not of standard quality and the other for sale of milk containing coloring matter.

For Fraudulent Sales of Milk — Concluded.

Place.	Date.	Result
In Waltham,	March 23, 1897,	Convicted.
Cambridge,	Sept. 30, 1897,	"
Quincy,	May 28, 1897,	"
Quincy,	Sept. 21, 1897,	"
Beverly,	Oct. 24, 1896,	"
Beverly,	Jan. 7, 1897,	"
Marblehead,	Oct. 14, 1896,	"
Marblehead,	Oct. 14, 1896,	"
Marblehead,	Oct. 14, 1896,	"
Marblehead,	Oct. 15, 1896,	"
Spencer,	Dec. 19, 1896,	"
Spencer,	May 14, 1897,	"
Sherborn,	March 13, 1897,	"
Sherborn,	July 10, 1897,	"
Sherborn,	Sept. 22, 1897,	"
Needham,	Oct. 2, 1896,	"
Upton,	Oct. 20, 1896,	"
Swanzey,	Dec. 4, 1896,	Discharged.
Westborough,	Nov. 11, 1896,	Convicted.
Wakefield,	Dec. 2, 1896,	"
Topsfield,	Feb. 12, 1897,	"
Southborough,	March 25, 1897,	"
Carlisle,	March 31, 1897,	"
New Braintree,	April 26, 1897,	"
Barre,	April 27, 1897,	"
Dana,	April 27, 1897,	"
Northfield,	May 27, 1897,	"
Rockport,	May 24, 1897,	"
Wareham,	Sept. 2, 1897,	"

Oleomargarine.

In Beverly,	March 11, 1897,	Convicted.
Lawrence,	Aug. 28, 1897,	"
Lawrence,	Aug. 28, 1897,	"
Total,		51

For Fraudulent Sale of Other Articles of Food.

Honey.

In Boston,	Dec. 29, 1896,	Convicted.

Coffee.

In Boston,	May 12, 1897,	Convicted.
Boston,	June 24, 1897,	"
Lawrence,	Aug. 28, 1897,	"
Malden,	Sept. 2, 1897,	"
Fall River,	July 30, 1897,	"

Molasses.

Place.	Date	Result.	
In Fall River,	Oct. 16, 1896,	Convicted.	
Gloucester,	May 28, 1897,	"	
Boston,	June 15, 1897,	"	
Allspice.			
In Malden,	Sept. 2, 1897,	Convicted.	
Cassia.			
In Boston,	Sept. 16, 1897,	Convicted.	
Mustard.			
In Lawrence,	Aug. 21, 1897,	Convicted.	
Maple Syrup.			
In Boston,	May 12, 1897,	Convicted.	
Total,			13

Drugs.

Lime Juice.

In Lawrence,	Sept. 24, 1897,	Convicted.

Summary.

Complaints entered in court under the acts relating to the inspection of milk and milk products,	51
Other articles of food,	13
Drugs,	1
Total,	65

Summary.

The whole number of complaints entered by the State Board of Health during the year ending Sept. 30, 1897, in the courts of the Commonwealth, against parties for violation of the statutes relating to food and drug inspection, was 65.

In 64, or 98.5 per cent., of these the parties were convicted. One was discharged.

Of the whole number, 51 were for the violation of the laws relating to adulteration of milk and milk products, and of this number 50 resulted in conviction. The greater number of these was for violation of the statute providing that milk offered for sale shall be of good standard quality.

In 7 of the foregoing cases the complaints were for sales of milk containing coloring matter.

The case of drug adulteration named in the foregoing summary was a flagrant violation of the law, and was as follows: the article

called for at the time of sale was lime juice, but the preparation furnished by the druggist contained no lime juice, but a substitute consisting mainly of a solution of muriatic and salicylic acids, and was, therefore, both a harmful and fraudulent adulteration. It was labelled "Santiago West Indian Lime Juice," and was made by the druggist who offered it for sale.

The attention of the Legislature is again respectfully called to the provisions of chapter 425 of the Acts of 1894, which debars any private citizen from maintaining an action against a producer for selling adulterated milk.

Attention is also respectfully called to the provisions of section 23 of chapter 397 of the Acts of 1896, by which the people are now deprived of the legal protection against the harmful action of poisonous patent medicines which they enjoyed under the poison act of 1888.

All of the parties against whom complaints were entered for fraudulent sales of other kinds of food were convicted.

The articles of food and drugs with reference to which these complaints were made were as follows: —

Maple syrup, 1 case; molasses, 3 cases;* oleomargarine, 3 cases; coffee, 5 cases; honey, 1 case; allspice, 1 case; cassia, 1 case; mustard, 1 case; lime juice, 1 case.

The following statute, as amended in 1896 (by chapter 398 of the Acts of that year), presents the standard of milk in Massachusetts at the date of publishing this report: —

[Acts of 1896, Chapter 398, Section 2.]

In all prosecutions under this chapter, if the milk is shown upon analysis to contain less than thirteen per cent. of milk solids, or to contain less than nine and three-tenths per cent. of milk solids, exclusive of fat, or to contain less than three and seven-tenths per cent. of fat, it shall be deemed, for the purposes of this act, to be not of good standard quality, except during the months of April, May, June, July and August, when milk containing less than twelve per cent. of milk solids, or less than nine per cent. of milk solids, exclusive of fat, or less than three per cent. of fat, shall be deemed to be not of good standard quality.

Four complaints were made during the year under the provisions of the new act of 1897, requiring that the name and percentage of each ingredient should be placed upon compound articles of food. Conviction resulted in each case.

* In one of these cases the extent of adulteration amounted to 75 per cent.

The law under which the complaints referred to in the foregoing paragraph were made reads as follows: —

[Chapter 344.]

An Act relative to the adulteration of food.

Section 1. No person shall within this Commonwealth manufacture for sale, offer for sale, or sell any article of food which is adulterated within the meaning of this act.

Section 2. The term "food," as used herein, shall include all articles used in food or drink by man, whether simple, mixed or compound.

Section 3. An article shall be deemed to be adulterated within the meaning of this act in the case of food: — 1. If any substance or substances have been mixed with it, so as to lower or depreciate or injuriously affect its quality, strength or purity. 2. If any inferior or cheaper substance or substances have been substituted wholly or in part for it. 3. If any valuable or necessary constituents or ingredient have been wholly or in part taken from it. 4. If it is in imitation of or is sold under the name of another article. 5. If it consists wholly or in part of a diseased, decomposed, putrid, tainted or rotten animal or vegetable substance or article, whether manufactured or not, or, in the case of milk, if it is produced from a diseased animal. 6. If it is colored, coated, polished or powdered in such a manner as to conceal its damaged or inferior condition, or if by any means it is made to appear better, or of greater value, than it really is. 7. If it contains any added substance or ingredient which is poisonous or injurious to health: *provided*, that the provisions of this act shall not apply to mixtures or compounds recognized as ordinary articles or ingredients of articles of food, if every package sold or offered for sale is distinctly labelled as a mixture or compound, with the name and per cent. of each ingredient therein, and if such mixtures or compounds are not injurious to health.

Section 4. No person shall offer for sale any canned articles of food after the first day of January in the year eighteen hundred and ninety-eight, except goods packed prior to the passage of this act, unless such articles bear a mark to indicate the grade or quality thereof, together with the name and address of the person, firm or corporation which packed the same, or of the dealer who sells the same.

Section 5. All canned articles of food prepared from dried products which have been soaked before canning shall be plainly marked by an adhesive label, having on its face the word "soaked," in letters not less in size than two line pica, of legible type; and all cans, jugs and other packages containing maple syrup or molasses shall be plainly marked by an adhesive label, having on its face the name and address of the person, firm or corporation which made or prepared the same, together with the name

and quality of the ingredients of the goods, in letters of the size and description above-specified.

SECTION 6. Any person, firm or corporation falsely stamping or labelling any cans, jars or other packages, containing fruit, or food of any kind, or knowingly permitting such false stamping or labelling, and any person, firm or corporation violating any of the provisions of this act, shall be deemed guilty of a misdemeanor, and shall be punished by a fine of not less than ten dollars nor more than one hundred dollars in the case of vendors, and in the case of manufacturers and those falsely or fraudulently stamping or labelling such cans, jars or other packages, by a fine of not less than one hundred dollars nor more than five hundred dollars.

SECTION 7. All acts and parts of acts inconsistent herewith are hereby repealed.

The first three sections of the foregoing act consist mainly in a repetition of the general statute of 1882 relating to food and drug inspection, so far as food is concerned, with a few changes, none of which appear to be important except the following, which occurs in the last clause of section 3.

The special clause following No. 7, section 3, with the introductory general clause, is as follows : —

3. An article shall be deemed to be adulterated within the meaning of this act in the case of food : — . . . *provided*, that the provisions of this act shall not apply to mixtures or compounds recognized as ordinary articles or ingredients of articles of food, if every package sold or offered for sale is distinctly labelled as a mixture or compound, *with the name and per cent. of each ingredient therein*, and if such mixtures or compounds are not injurious to health.

Sections 4, 5 and 6 are entirely new legislation.

The following list presents the total solids in each of the samples of milk upon which complaints were founded, so far as records of the same were kept : —

6.80	10.19	10.70	11.20
7.12	10.19	10.83	11.23
8.50	10.42	10.92	11.26
9.00	10.43	11.03	11.38
9.05	10.53	11.07	11.48
9.32	10.63	11.10	11.50
9.36	10.64	11.10	11.62
10.19	10.64	11.18	11.78
10.19			

The total number of samples of food and drugs examined during the year was as follows: —

Milk,	6,104
Other articles of food,	3,926
Drugs,	690
Total,	10,720
Total expenses of collection, examination and prosecution,	$12,076 43
Average expense per sample collected,	1 13

Fines.

The amount of fines paid into the treasuries of counties, cities and towns under the provisions of the general and special laws relative to the inspection of food and drugs was as follows: —

Fines paid for Violation of the Food and Drug Acts, upon Cases entered for the Year ending Sept. 30, 1897.

Under the provisions of the laws relating to milk and milk products,	$2,088 40
Under the provisions of the laws relating to other articles of food,	638 20
Under the provisions of the laws relating to drugs,	30 00
	$2,756 60

Expenditures

Under the Provisions of the Food and Drug Acts during the Year ending Sept. 30, 1897.

	For the Enforcement of the Statutes relating to Food and Drug Inspection.	
	Relative to Milk and Milk Products.	Relative to Other Kinds of Food and Drugs.
Salaries of analysts,	$2,903 00	$1,936 00
Salaries of inspectors,	2,500 00	1,550 00
Travelling expenses and purchase of samples,	1,145 00	753 90
Apparatus and chemicals,	534 59	356 40
Books,	–	11 00
Index cards,	20 00	12 45
Express charges,	5 85	40 05
Extra services for inspection,	174 00	116 00
Sundry small supplies (bottles, towels, case for samples, etc.),	11 19	7 00
	$7,293 63	$4,782 80
		7,293 63
Total,	. . . .	$12,076 43*

* The appropriation for food and drug inspection in each of the years 1896 and 1897 was $11,500, and the expenditures under this appropriation did not exceed that amount in either year. The amount specified in the foregoing statement ($12,076.43) was expended in the twelve months ended Sept. 30, 1897.

REPORT OF THE ANALYST.

REPORT OF THE ANALYST.

Dr. S. W. Abbott, *Secretary of the State Board of Health.*

Dear Sir: — I have the honor to present my report of the analysis of food and drugs for the year ending Sept. 30, 1897.

Milk.

As was noted in the preceding report, a material drop occurred in the ratio of adulteration of milk analyzed during the year ending Sept. 30, 1896. This apparent improvement in quality caused the milk of that year to appear, in the ratio of adulteration, to be 15 per cent. better than that of the preceding years. This was due to the fact that the legal standard for the total solids of milk was lowered from 13 per cent. to 12 per cent. for the months of April and May. The law was enacted too late in 1896 to include the month of April, so that this year, as might be expected with 12 per cent. as a standard from April to August inclusive, a still lower ratio of adulteration is shown for the year, viz., 31.6 per cent.

Milk Preservatives.

During the hot summer months a systematic inspection of all the milk samples received was made for preservatives, the ash of each milk being examined for boracic acid and sodium carbonate, while a separate portion of the milk sample was examined for formalin.

Methods employed for the Detection of Preservatives.

Formalin. — Our chief reliance for the detection of formalin has been placed on the fuchsine test. One cubic centimeter of the fuchsine reagent (1 gram to 500 cubic centimeters decolorized by sulphurous acid) is added to ten cubic centimeters of milk. The mixture is shaken and allowed to stand five minutes. Two cubic

centimeters of hydrochloric acid (specific gravity, 1.2) are then added, when the presence of formalin is indicated by a violet color.

By the foregoing test the presence of formaldehyde is readily detected in the strength of 1 part to 20,000 of the milk. This test may be increased in delicacy by distilling the milk containing formalin and treating with a drop of the fuchsine reagent the first portion of the distillate; in this manner 1 part of formaldehyde in 500,000 of milk may be detected.

At the same time we have been employing tentatively a simpler method of testing for formalin, which has so far proved reliable and very delicate. Ten cubic centimeters of hydrochloric acid (specific gravity, 1.2) are added to an equal amount of milk in a porcelain dish. A drop of ferric chloride solution (reagent strength) is added and the mixture heated to just below the boiling point with vigorous stirring. The presence of formalin is indicated by a violet coloration varying in depth with the amount present. By this test 1 part of formaldehyde in 500,000 parts of milk is readily detected before the milk sours; after souring, the limit of delicacy proves to be about 1 part in 50,000.

The power of formalin in preserving milk is roughly shown in the following table, which gives the result of experiments made in the laboratory.

Fresh milk of known purity was thoroughly mixed and divided into six samples. The preservative was added within three hours of milking, and the samples were kept on ice during the period of the test.

Action of Formaldehyde upon Milk.

Relative Amounts of Formaldehyde in the Milk.*	Number of Hours before Curdling.	First Day.		Second Day.		Third Day.		Fourth Day.		Sixth Day.		Eighth Day.		Ninth Day.	
		Acidity.†	Condition.	Acidity.†	Condition.	Acidity.†	Condition.	Acidity.†	Condition.	Acidity.†	Condition.	Acidity.†	Condition.	Acidity.†	Condition.
(1) None,	30	0.80	Sweet.	0.80	Sweet.	4.46	Curdled.	-	-	-	-	-	-	-	-
(2) 1 part to 100,000,	36	0.80	Sweet.	0.80	Sweet.	2.65	Curdled.	-	-	-	-	-	-	-	-
(3) 1 part to 50,000,	54	0.80	Sweet.	0.80	Sweet.	1.16	Sweet.	4.25	Curdled.	-	-	-	-	-	-
(4) 1 part to 20,000,	78	0.80	Sweet.	0.81	Sweet.	1.03	Sweet.	1.16	Sweet.	4.14	Curdled.	-	-	-	-
(5) 1 part to 10,000,	168	0.80	Sweet.	0.86	Sweet.	0.93	Sweet.	1.06	Sweet.	1.15	Sweet.	5.75	Curdled.	-	-
(6) 1 part to 5,000,	186	0.80	Sweet.	0.91	Sweet.	0.96	Sweet.	1.00	Sweet.	1.07	Sweet	1.40	Sweet.	4.86	Curdled.

* Commercial formalin contains approximately 40 per cent. of formaldehyde, so that 1 part of the aldehyde would be the equivalent of 2½ parts of formalin.

† Acidity expressed in number of cubic centimeters of decinormal Na OH required to neutralize 5 cubic centimeters of the milk.

Boracic Acid and Sodium Carbonate. — The ash of the 5 cubic centimeters of milk used for the determination of the total solids was in each case examined for sodium carbonate and for boracic acid. Two drops of dilute hydrochloric acid were added to each of the platinum dishes containing a milk ash. If effervescence occurred the original milk was further examined by the rosolic acid test. Effervescence in the milk ash is quite perceptible when this carbonate is present in as small amount as .05 per cent.

In the test for boracic acid the hydrochloric solution of the milk ash was diluted with about 2 cubic centimeters of water. This solution was tested for boracic acid by the ordinary method, with turmeric paper.

The customary statistics of milk adulteration will be found in the following tables: —

Milk from Cities.

Cities.	Total Samples Collected.	Above Standard.	Below Standard.	Per Cent. below Standard.	Total Solids in Lowest Sample.	Number of Skimmed Samples.	Number of Colored Samples.	Number of Preserved Samples.
Boston, . . .	358	231	127	35.5	10.85	1	-	-
Brockton, . .	97	73	24	24.7	9.05	1	4	-
Cambridge, . .	418	277	141	33.7	10.24	4	-	-
Chelsea, . . .	276	167	109	39.0	7.56	1	-	1
Everett, . . .	100	59	41	41.0	9.85	5	-	-
Fall River, . .	218	150	68	31.2	8.32	-	-	-
Fitchburg, . .	70	52	18	25.7	10.10	7	-	-
Gloucester, . .	162	127	35	21.5	11.03	-	4	2
Haverhill, . .	69	61	8	11.5	11.23	-	1	-
Lawrence, . .	84	58	26	30.9	11.35	2	-	-
Malden, . . .	230	128	102	44.3	8.43	1	23	-
Marlborough, .	62	56	6	9.6	11.10	-	-	-
Medford, . .	278	188	90	32.4	11.09	-	-	-
New Bedford, .	74	63	11	14.8	10.63	-	2	-
Newburyport, .	39	35	4	10.3	10.93	-	-	-
Newton, . . .	204	135	69	33.8	10.60	2	-	-
Quincy, . . .	100	75	25	25.0	11.20	-	-	-
Salem, . . .	103	80	23	23.4	10.49	-	-	2
Somerville, . .	597	407	190	31.8	9.40	4	-	-
Springfield, . .	16	9	7	43.1	11.30	1	-	-
Taunton, . .	57	45	12	21.0	11.19	4	-	-
Waltham, . .	180	100	80	44.4	9.45	3	5	-
Woburn, . .	77	52	25	32.4	10.57	-	-	-
Worcester, . .	136	69	67	49.2	10.90	-	-	-
Totals, . .	4,005	2,697	1,308	32.6	7.56	36	39	5

Milk from Towns.

Towns.	Total Samples Collected.	Above Standard.	Below Standard.	Per Cent. below Standard.	Total Solids in Lowest Sample.	Number of Skimmed Samples.	Number of Colored Samples.	Number of Preserved Samples.
Abington, . .	23	19	4	17.4	11.14	-	-	-
Arlington, . .	10	3	7	70.0	11.52	-	-	-
Beverly, . . .	65	51	14	21.5	10.70	2	-	-
Brookline, . .	154	123	31	20.1	10.72	-	-	-
Canton, . . .	30	22	8	23.3	11.66	-	-	-
Clinton, . . .	30	23	7	23.3	11.62	5	-	-
Dedham, . .	110	84	26	23.6	10.48	-	-	-
Dudley, . . .	4	3	1	25.0	9.45	-	-	-
Easton, . . .	10	4	6	60.0	12.00	-	-	-
Framingham, .	29	21	8	27.9	12.36	1	-	-
Greenfield, . .	26	26	0	0.0	12.20	-	-	-
Hingham, . .	7	7	0	0.0	13.00	-	-	-
Hopkinton, . .	15	13	2	13.3	12.20	-	-	-
Hudson, . . .	3	2	1	33.3	10.08	1	-	-
Hull, . . .	37	28	9	24.3	11.30	-	-	5
Hyde Park, . .	124	81	43	34.7	11.38	-	-	-
Middleborough, .	7	6	1	14.3	11.60	1	-	-
Milford, . . .	76	67	9	11.8	11.32	-	-	4
Nantucket, . .	20	20	0	0.0	12.00	-	-	-
Natick, . . .	94	68	26	27.6	10.85	-	-	-
Provincetown, .	21	20	1	4.8	11.13	-	-	-
Randolph, . .	6	5	1	16.6	12.84	-	-	-
Revere, . . .	54	30	24	44.4	10.86	-	-	-
Rockland, . .	7	7	0	0.0	12.24	-	-	-
Salisbury, . .	18	17	1	5.5	11.74	-	-	-
Spencer, . .	14	6	8	57.1	12.10	1	-	-
Stoneham, . .	102	81	21	20.6	11.46	4	-	-
Stoughton, . .	136	111	25	18.4	11.04	-	-	-
Swanzey, . .	22	5	17	77.3	10.52	-	-	-
Wakefield, . .	30	25	5	16.6	10.66	1	-	-
Wareham, . .	22	16	6	27.3	7.65	-	-	-
Watertown, . .	46	37	9	19.5	10.20	1	-	-
Webster, . .	27	21	6	22.2	12.40	2	-	-
Westborough, .	28	21	7	25.0	9.80	-	-	-
Winchester, . .	76	60	16	21.0	8.06	-	-	-
Winthrop, . .	72	47	25	34.7	10.38	-	-	-
Totals, . .	1,555	1,180	375	24.1	7.65	19	-	9

Milk from Suspected Producers.

Locality.	Total Samples Collected.	Above Standard.	Below Standard.	Per Cent. below Standard.	Total Solids in Lowest Sample.	Number of Colored Samples.
Barre, ...	10	2	8	80.0	10.19	-
Bedford, ...	26	8	18	69.2	9.91	-
Carlisle, ...	10	0	10	100.0	10.19	-
Charlton, ...	35	18	17	48.6	6.80	-
Dedham, ...	14	0	14	100.0	11.73	-
Framingham, ...	13	7	6	46.1	12.56	-
Freetown, ...	16	9	7	43.7	12.20	-
Hardwick, ...	13	0	13	100.0	7.65	-
Holliston, ...	3	2	1	33.3	12.10	-
Montague, ...	18	0	18	100.0	9.00	-
Needham, ...	15	9	6	40.0	10.83	-
Northborough, ...	12	5	7	58.3	11.40	-
North Brookfield, ...	16	2	14	87.5	10.70	-
Rochedale, ...	3	0	3	100.0	8.50	-
Sherborn, ...	20	10	10	50.0	10.53	-
Somerset, ...	15	14	1	6.6	12.54	-
Southborough, ...	15	15	0	0.0	-	15
Spencer, ...	10	0	10	100.0	11.10	-
Walpole, ...	10	8	2	20.0	12.70	-
Totals, ...	274	109	165	60.2	6.80	15

Analysis of Milk of Known Purity.

Age of Cow.	Time Since Calving	Breed.	Results of Analysis.						
			Specific Gravity.	Fat.	Sugar.	Albuminoids.	Ash.	Total Solids.	Water.
Years.	Months.								
$3\frac{1}{2}$, . .	6	Holstein.	1.028	3.40	4.50	3.27	0.55	11.22	88.78
$6\frac{1}{2}$, . .	7	"	1.029	3.80	4.10	3.63	0.50	12.03	87.97
5, . .	3	"	1.029	3.30	4.30	4.44	0.64	12.68	87.32
$6\frac{7}{12}$, .	4	"	1.030	3.20	4.00	3.44	0.51	11.15	88.85
$4\frac{1}{4}$, . .	4	"	1.028	6.20	3.00	4.87	0.65	14.82	85.18
$6\frac{1}{2}$, . .	5	"	1.029	2.60	4.30	3.02	0.60	10.52	89.48
$6\frac{1}{2}$, . .	11	"	1.031	3.80	4.00	4.07	0.50	12.37	87.63
$11\frac{1}{6}$, . .	2	"	1.031	3.40	4.10	3.69	0.58	11.77	88.23
$6\frac{1}{4}$, . .	4	"	1.031	3.60	4.00	4.10	0.56	12.26	87.74
11, . .	$1\frac{1}{2}$	"	1.029	2.70	3.50	3.46	0.56	10.22	89.78
$3\frac{1}{3}$, . .	11	"	1.033	3.80	4.40	3.92	0.68	12.80	87.20
$6\frac{1}{4}$, . .	7	"	1.032	4.20	4.30	4.30	0.62	13.42	86.58
$5\frac{1}{6}$, . .	3	"	1.030	3.30	4.40	3.05	0.68	11.43	88.57
$3\frac{1}{4}$, . .	6	"	1.031	3.20	4.50	3.40	0.62	11.72	88.28
$2\frac{1}{2}$, . .	–	"	1.031	4.70	4.30	3.89	0.66	13.55	86.45
$2\frac{5}{6}$, . .	2	"	1.031	3.40	4.40	3.78	0.67	12.25	87.75
$4\frac{1}{3}$, . .	4	"	1.031	3.40	4.60	4.16	0.62	12.78	87.22
$9\frac{1}{3}$, . .	8	"	1.030	2.70	4.00	3.42	0.42	10.54	89.46
$3\frac{5}{12}$, .	4	"	1.030	3.00	4.00	3.73	0.62	11.35	88.65
$3\frac{7}{12}$, .	9	"	1.033	3.70	4.00	4.07	0.70	12.47	87.53

The average total solids of the foregoing samples from twenty Holstein cows was 12.07 per cent.

Quality of Milk by Months.

Months.	Total Samples Collected.	Above 13 Per Cent.	Below 13 Per Cent.	Below 12 Per Cent.	Ratio below 13 Per Cent.	Ratio below 12 Per Cent.
October,	530	314	216	43	40.7	8.1
November,	423	268	155	28	36.6	6.6
December,	438	246	192	26	43.9	5.9
January,	356	217	139	31	38.9	8.7
February,	479	252	227	50	47.4	10.4
March,	498	252	246	57	49.3	11.0
April,	552	242	310	104	56.1	18.8
May,	482	210	272	57	56.4	11.8
June,	519	238	281	52	54.0	10.0
July,	537	204	333	64	62.0	11.9
August,	524	186	338	78	64.7	14.9
September,	502	182	320	63	63.7	12.3
Totals,	5,840	2,811	3,029	653	51.8	11.2

Summary of Milk Statistics.

	Total Samples Collected.	Above Standard.	Below Standard.	Per Cent. below Standard.	Total Solids in Lowest Sample.	Number of Skimmed Samples.	Number of Colored Samples.	Number of Preserved Samples.
Cities,	4,005	2,697	1,308	32.6	7.56	36	39	5
Towns,	1,555	1,180	375	24.1	7.65	19	-	9
Suspected producers,	274	109	165	60.2	6.80	-	15	-
Miscellaneous,	6	4	2	33.3	9.62	-	-	-
Totals,	5,840	3,990	1,850	31.6	6.80	55	54	14

Condensed Milk.

A large number of brands of condensed milk have been examined and have been found, almost without exception, to be of good quality. Samples, however, of so-called evaporated cream are frequently of poor quality. Some of them are made from skim-milk, and have nothing in common with cream except their consistency. Canned condensed milk has become a very important article of food in our cities, particularly in the poor quarters, and it is gratifying to find that as usually supplied it is an honest article.

Condensed Milks.

Brand.	Total Solids.	Water.	Milk Solids.	Cane Sugar.	Milk Sugar.	Proteids.	Fat.	Ash.	Fat in Original Milk.	Price per Pound, in Cents.
Pure Food,	68.70	32.30	30.27	38.43	6.38	10.70	11.46	1.73	5.67	16
Pure Food,	72.05	27.95	39.11	32.94	13.09	12.35	12.00	1.67	4.13	16
Bell,	74.25	25.75	32.65	41.60	11.20	8.49	11.40	1.56	4.96	12
Pure Food,	66.03	33.97	32.79	33.24	11.15	9.19	11.10	1.35	4.76	17
Nestle's Swiss,	74.75	25.25	33.09	41.66	11.17	9.44	10.80	1.68	4.58	17
Holstein,	74.12	25.88	33.15	40.97	12.47	7.69	10.80	2.25	4.50	12
Rose,	75.62	24.38	32.81	42.81	11.51	8.71	10.80	1.79	4.15	11
Hampden,	73.35	26.65	30.93	42.42	10.50	8.26	10.50	1.67	4.78	17
Magnolia,	73.62	26.38	28.57	45.05	10.80	5.55	10.80	1.42	5.71	10
Tip Top,	76.21	23.79	31.68	44.53	13.14	6.54	10.35	1.65	4.50	11
Hampden,	70.16	29.84	31.83	38.23	10.90	9.00	10.35	1.58	4.50	17
Hampden,	71.06	28.94	29.88	41.18	8.40	9.47	10.35	1.66	4.93	17
Maine's Favorite,	71.34	28.66	34.58	36.76	12.27	10.49	10.20	1.62	2.80	10
Defiance,	73.65	26.35	33.44	40.21	14.20	7.79	9.90	1.55	3.91	-
Maine,	71.27	28.73	31.54	39.73	11.55	8.59	9.90	1.50	4.25	11
Gail Borden Eagle,	65.88	34.12	29.58	36.30	11.17	7.01	9.90	1.50	4.41	18
Gold Medal,	74.90	25.10	32.63	42.27	9.57	11.51	9.90	1.65	3.69	10
Challenge,	73.27	26.73	30.44	42.83	13.40	5.61	9.90	1.53	4.50	15
Rose,	75.69	24.31	33.12	42.57	12.90	8.67	9.90	1.65	6.60	11
Clover,	71.84	28.16	34.62	37.22	14.73	8.62	9.54	1.73	3.58	8
Quaker,	70.30	29.70	30.93	39.37	10.31	9.82	9.42	1.38	4.08	8
Tip Top,	75.15	24.85	35.23	39.92	13.95	8.91	9.30	1.75	3.33	11
Perfect,	74.31	25.69	29.55	44.76	10.90	7.54	9.30	1.81	4.27	12
Magnolia,	72.15	27.75	35.05	37.20	14.76	9.29	9.30	1.70	3.45	10
Full Weight,	76.55	23.45	31.99	44.56	12.35	9.34	9.00	1.30	3.64	-
Leader,	69.00	31.00	27.74	41.26	9.30	7.94	9.00	1.50	4.46	10
Challenge,	76.90	23.10	34.51	42.39	14.30	9.23	9.18	1.80	3.37	15
Fern,	77.15	22.85	31.29	45.86	12.41	8.16	9.00	1.72	3.75	12
Sweet Clover,	73.15	26.85	24.79	48.36	7.78	6.51	9.00	1.50	5.66	10
Diamond W.,	74.95	25.05	32.28	42.67	11.75	9.98	9.00	1.55	3.60	10
Milk Maid,	75.03	24.97	31.17	43.86	13.67	7.02	9.00	1.48	3.78	18
Porcelain,	70.15	29.85	30.28	39.87	7.22	11.55	9.25	2.27	4.13	15
Holstein,	73.36	26.84	30.30	43.06	12.18	7.99	9.00	1.13	4.36	11
Pennant,	70.98	29.02	30.39	40.59	11.88	7.43	9.00	2.08	4.18	11
Knight,	77.43	22.57	33.43	44.00	12.64	9.85	9.00	1.94	3.45	15
Pansy,	77.00	23.00	31.94	45.06	11.61	9.51	9.00	1.82	3.24	12

Condensed Milks — Concluded.

Brand.	Total Solids.	Water.	Milk Solids.	Cane Sugar.	Milk Sugar.	Proteids.	Fat.	Ash.	Fat in Original Milk.	Price per Pound, in Cents.
Gold Medal,	74.72	25.28	27.95	46.75	10.20	7.42	8.85	1.50	4.32	11
Pennant,	70.13	29.87	27.36	42.75	9.07	7.74	8.70	1.87	4.35	10
Michigan,	71.55	28.45	21.99	49.56	5.80	5.76	8.70	1.73	6.11	9
Magnolia,	72.00	28.00	31.95	40.85	12.64	8.66	8.40	1.45	3.38	10
Russell's,	70.05	29.95	31.64	38.41	13.40	8.29	8.40	1.55	3.36	11
J. B. Smith,	74.30	25.70	36.71	38.59	15.58	10.04	8.40	1.73	2.77	10
Daisy,	73.90	26.10	30.60	43.30	9.57	9.24	8.40	1.64	3.57	13
Sweet Clover,	76.21	23.79	27.65	48.56	7.96	9.38	8.40	1.91	4.06	10
Winthrop,	65.55	34.45	30.28	35.27	9.50	10.74	8.25	1.59	3.59	–
Dirigo,	73.20	26.80	33.47	39.73	14.09	9.55	8.28	1.55	3.05	10
Rival,	74.87	25.13	28.92	45.95	9.85	9.57	8.10	1.40	6.31	10
Peninsula,	76.48	23.52	30.94	45.54	11.49	9.37	7.98	2.10	5.26	11
Crescent,	72.11	27.89	29.63	43.48	11.28	7.70	7.92	1.73	3.40	11
Union,	73.35	26.65	26.40	46.95	7.24	9.28	7.90	1.98	3.93	11
Jersey,	69.65	30.35	26.49	43.16	8.30	9.29	7.80	1.40	3.88	12
Baby,	69.50	30.50	30.21	39.29	11.60	8.44	7.80	2.37	3.23	23
Standard,	70.50	29.50	29.29	41.21	11.55	8.44	7.80	1.50	3.37	11
Milk Maid,	76.45	23.55	35.95	40.50	14.90	9.59	7.80	1.77	2.54	10
Baby,	69.30	30.70	30.10	39.20	11.10	10.06	7.35	1.59	3.06	23
Beacon,	69.30	30.70	31.83	37.47	16.75	6.34	7.20	1.54	2.72	10
Anchor,	67.70	32.30	36.14	31.56	15.90	11.42	6.90	1.92	3.14	–
Ten Cent,	78.53	21.47	32.48	46.05	13.62	10.70	6.60	1.56	2.38	9
American,	71.37	28.63	36.04	35.23	19.63	8.90	6.00	1.62	1.86	15
Winooski,	69.25	30.75	28.94	40.31	12.20	9.29	6.00	1.45	2.02	11
Winooski,	69.10	30.90	31.22	37.88	14.38	9.19	6.00	1.65	2.16	10
Vermont,	68.95	31.05	28.57	40.38	12.23	9.04	5.70	1.60	2.32	11

Evaporated Cream.

Brand.	Total Solids.	Water.	Cane Sugar.	Milk Sugar.	Proteids.	Fat.	Ash.	Fat in Original Milk
Highland, ...	31.09	68.91	-	10.74	7.57	9.66	1.64	4.20
Highland, ...	29.62	70.38	-	10.65	7.19	9.60	1.30	4.36
Imperial, ...	35.15	64.85	-	11.17	9.41	9.60	1.70	3.55
Imperial, ...	35.45	64.55	-	11.35	9.44	9.60	1.67	3.55
Borden's Peerless, ...	31.14	68.86	-	11.55	8.68	9.00	1.42	3.75
Highland, ...	30.76	69.24	-	9.85	8.66	8.10	1.55	3.38
St. Charles, ...	29.91	70.09	-	10.00	8.26	7.80	1.67	3.39
St. Charles, ...	29.43	70.57	-	10.00	8.64	7.80	1.51	3.39
Superb, ...	29.38	70.62	-	9.85	8.39	7.28	1.43	3.16
Borden's Peerless, ...	30.58	69.42	-	11.06	10.78	6.54	1.50	2.54
Superb, ...	35.17	64.83	-	13.29	15.37	4.20	1.70	1.29
Boston Condensed Milk Company,	36.06	63.94	5.96	15.20	12.88	Trace.	2.02	Trace.

Butter.

Of 420 samples examined, 6 proved to be oleomargarine. As in previous years, we have depended upon the refractometer to indicate suspicious samples, whose volatile acids are then determined.

Cheese.

The 96 samples submitted proved to be all of good quality.

Lard.

Of 33 samples submitted, 3 proved to be adulterated with tallow.

Olive Oil.

Of 20 samples submitted, 6 proved to be adulterated with seed oil.

Honey.

Of 88 samples examined, 28 were adulterated with glucose syrup. The extent of the adulteration in one case was 90 per cent.

Molasses.

Of 296 samples, 17 were adulterated with glucose syrup. One sample contained over 60 per cent. of the adulterant.

Syrups.

Of the 35 samples examined, 25 were adulterated with glucose syrup. The addition of this adulterant to refiners' syrups appears to be a favorite means of thickening their consistency and at the same time rendering milder their naturally strong taste. There can be no objection to such admixture provided the article is properly labelled as a compound.

Maple Sugar.

Of 33 samples, 8 proved to be wholly or in part crude cane sugar.

Maple Syrup.

Of 52 samples, 11 were adulterated with glucose syrup, or with sugar-house drips.

Ground Spices.

Allspice. — Of 137 samples, 8 were adulterated. The usual adulterants were found: wheat, ginger, nut-shells, peas and ground fruit stones.

Cassia. — Of 249 samples, 21 proved adulterated with the materials usually employed.

Cayenne. — Of 68 samples, 16 were adulterated. The ratio of adulteration shows some improvement over last year.

Cloves. — Of 320 samples, 39 were adulterated.

Ginger. — Of 243 samples, 30 were adulterated.

Mace. — Of 30 samples, 3 were adulterated.

Mustard. — Of 273 samples, 85 were adulterated.

Nutmeg. — Of 19 samples, 2 were adulterated.

Pepper. — Of 360 samples, 30 were adulterated.

Vinegar.

The percentage of adulteration of vinegar is about as large as usual. Outside the city of Boston little or no care appears to be

taken by the grocers to supply a standard article. The law demands that cider vinegar shall contain at least 4.5 per cent. of acetic acid, and at least 2 per cent. of vinegar solids on evaporation.

The following table shows what a large percentage of samples failed to meet these requirements. Those below the standard are in full-face type.

Percentage of Acetic Acid.	Percentage of Solids.	Percentage of Acetic Acid.	Percentage of Solids.	Percentage of Acetic Acid.	Percentage of Solids.	Percentage of Acetic Acid.	Percentage of Solids.	Percentage of Acetic Acid.	Percentage of Solids.	Percentage of Acetic Acid.	Percentage of Solids.
6.15	**0.29**	4.96	2.46	4.79	2.74	**4.67**	**1.47**	**4.50**	**1.10**	**4.30**	**1.16**
6.13	2.20	4.95	2.80	4.77	2.52	**4.67**	**1.20**	**4.50**	**0.33**	**4.28**	**0.36**
5.80	2.16	4.93	4.28	4.76	2.06	**4.66**	**1.26**	4.50	2.78	**4.25**	**0.50**
5.80	2.10	**4.93**	**1.35**	4.76	2.40	4.65	2.22	4.50	2.66	**4.20**	**2.03**
5.42	**1.50**	**4.93**	**1.88**	4.75	2.36	4.65	2.26	4.50	3.70	**4.17**	**1.10**
5.40	2.00	4.92	2.70	4.75	2.58	**4.65**	**1.84**	4.50	2.60	**4.10**	**1.10**
5.36	**1.87**	**4.92**	**1.70**	4.75	2.42	4.65	2.30	4.50	2.47	**4.00**	**1.78**
5.30	**1.58**	4.92	2.50	4.75	3.08	4.64	2.58	**4.50**	**1.58**	**4.00**	**2.18**
5.30	**1.98**	**4.90**	**1.94**	**4.75**	**0.48**	**4.62**	**1.96**	4.50	2.52	**3.92**	**3.60**
5.30	**0.32**	4.90	2.90	4.75	2.32	4.62	2.00	4.50	2.42	**3.80**	**2.48**
5.27	**1.70**	**4.90**	**1.80**	4.75	6.10	**4.61**	**1.27**	**4.49**	**1.88**	**3.80**	**2.80**
5.20	**1.71**	4.90	2.00	**4.75**	**1.30**	**4.60**	**0.28**	**4.49**	**1.67**	**3.72**	**2.50**
5.20	**1.32**	4.89	2.76	**4.73**	**1.32**	**4.60**	**1.70**	**4.48**	**2.38**	**3.70**	**2.26**
5.20	2.82	**4.88**	**1.20**	4.73	2.20	4.60	3.12	**4.47**	**2.06**	**3.64**	**2.15**
5.20	2.62	**4.87**	**1.39**	4.73	4.10	4.60	2.14	**4.45**	**2.02**	**3.62**	**1.78**
5.17	2.94	4.86	2.60	4.70	3.48	**4.60**	**1.40**	**4.45**	**1.68**	**3.55**	**2.18**
5.16	2.16	**4.84**	**1.66**	**4.70**	**1.42**	4.58	2.76	**4.45**	**0.38**	**3.50**	**2.16**
5.15	2.74	4.83	2.67	4.70	2.64	**4.57**	**1.74**	**4.43**	**2.80**	**3.36**	**0.90**
5.15	2.24	4.83	2.10	4.70	2.50	4.57	-*	**4.43**	**2.96**	**3.36**	**2.43**
5.10	2.82	**4.82**	**1.49**	4.70	3.40	4.57	4.20	**4.43**	**2.98**	**3.35**	**2.02**
5.10	2.38	4.82	-*	**4.70**	**0.48**	4.56	2.64	**4.43**	**2.28**	**3.29**	**2.00**
5.10	2.26	4.82	2.50	4.70	2.00	4.55	2.10	**4.42**	**0.38**	**3.28**	**1.65**
5.09	**1.66**	**4.81**	**0.35**	**4.70**	**1.25**	4.55	2.02	**4.40**	**1.60**	**3.25**	**-***
5.06	**1.08**	4.80	2.86	**4.70**	**0.32**	4.55	2.00	**4.38**	**0.37**	**3.05**	**2.70**
5.05	**1.23**	4.80	2.98	**4.69**	**1.93**	**4.54**	**1.92**	**4.38**	**4.20**	**2.80**	**2.56**
5.05	**1.78**	**4.80**	**1.72**	4.69	2.54	**4.54**	**1.12**	**4.37**	**1.85**	**2.40**	**1.52**
5.00	**1.20**	**4.80**	**0.36**	**4.68**	**1.58**	**4.52**	**1.44**	**4.35**	**2.00**	**1.40**	**2.24**
4.97	**1.54**	**4.80**	**1.70**	**4.68**	**1.05**	**4.52**	**1.42**	**4.30**	**3.32**		

* White wine.

TEA.

Of 103 samples, 3 proved of such poor quality as to justify the term adulterated.

COFFEE.

Nineteen of the 159 samples examined proved to be adulterated.

Several coffee substitutes appear to have established a considerable demand for themselves in the market. A sample labelled "Entire Wheat Coffee" was found to contain a considerable proportion of peas. "Old Grist-Mill Entire Wheat Coffee" was found to contain, besides wheat, peas and genuine coffee. It is set forth on the label to be "a perfect hygienic product, containing the entire wheat kernel roasted and ground." Nothing is said of its other constituents, and this omission has led to misunderstanding.

COCOA (INCLUDING CHOCOLATE PREPARATIONS).

Of 38 samples, 13 were adulterated. These were samples of cocoa which are frequently found "prepared" by the addition of wheat, corn, rice or arrowroot starch, together with large amounts of sugar and occasionally a little flavoring, such as vanilla.

CONFECTIONERY.

Fifty-nine samples of candy were examined, and were found, without exception, to be composed of harmless ingredients.

CREAM OF TARTAR.

Of 407 samples, 10 proved to be cream of tartar substitutes wholly or in part. One was found whose acidity was one-sixth the standard strength, and which consisted of the phosphate and sulphate of lime with alum and corn-starch.

MISCELLANEOUS.

Of 198 samples classed under this head, 44 proved to be adulterated.

Under this head are included 9 samples of baking powders, 6 of which contained alum.

A sample of clam juice contained 0.25 grams of salicylic acid per 450 cubic centimeters.

Samples of pickles proved to be in no case artificially colored.

"Vanilla crystals" proved to be composed of granulated sugar flavored with coumarin.

A vanilla extract consisted of an alcoholic solution of sugar colored with caramel and flavored with coumarin.

A sample of "Egg food" consisted chiefly of corn-starch.

The tin foils used as food wrappers, and other tin and lead alloys which are used as parts of vessels containing foods or drinks, have been investigated to determine their percentage of lead.

The following table shows the character of the sample and the percentage of lead found in the wrapping foil: —

	Per Cent.
English arrowroot,	89.00
Meadow sweet cheese,	85.50
Green Mountain cheese,	45.90
Cream cheese (star brand),	2.80
French sausage,	2.10
Chocolate Menier,	0.87
Chocolate cakes,	0.80
Fleischman's yeast cakes,	0.80
Saratoga cheese,	0.70
Lemon wrappers,	0.20
Chocolate cream wrappers,	Trace.

The brilliantly colored French "Haricots Verts" are usually sold in a wide-mouthed bottle which is closed by a disk of very soft metal. This metallic cap, which comes in direct contact with the liquid contents of the bottle, was found to contain 93½ per cent. of lead. Of the various kinds of bottle in which are sold cheap carbonated drinks, known as "pop," one style was found having a stopper consisting of a metallic button surrounded by a rubber ring. The metallic button was found to consist of tin and lead in varying proportions. Inasmuch as the enclosed liquor usually was found to be quite acid in reaction, the danger of prolonged contact with the metallic stopper is evident.

The following table gives the percentage of lead found in the stoppers of this character, together with the amount of lead contained in the liquor: —

Character of Sample.	Brand Blown in Bottle.	Percentage of Lead in Stopper.	Amount of Lead in Contents, in Milligrammes.
Blood Orange,	William Ryan, 221 Third Street, S.W., Washington, D.C., .	50.7	0.31
-* . .	O'Connell Bros., ...	50.3	1.05
-* . .	——— ———, ...	50.3	0.45
-* . .	Sawyer, Batchelder & Co., Lowell, Mass., ...	49.6	0.01
Birch Beer, .	John H. Boulger, North Adams, Mass. (registered), . .	35.0	Large trace.
Ginger, . .	Glendale Spring Company, Everett, Mass. (registered), .	32.2	0.40
-* . .	S. B. Winn & Son, ...	11.0	0.30
-* . .	C. B. W. S. Company, Boston, Mass., ...	10.8	0.17
-* . .	C. H. Cutter, Lexington, Mass. (registered), ...	10.0	0.07
-* . .	Wm. F. Collins, South Framingham, Mass., ...	9.8	0.30
-* . .	Mt. Washington Cold Spring Manufacturing Company, 18 Broad Street, Boston, Mass.	9.6	0.06
Strawberry, .	Fairbanks & Snyder, Boston, Mass. (this bottle not to be sold),	8.8	0.20
Sarsaparilla, .	J. J. Blackford, Lynn, Mass., ...	8.5	0.19
Lemon, . .	C. B. W. S. Company, Boston, Mass., ...	7.5	0.27
-* . .	F. P. Cummings, Bottler, Pocohontas, Va., ...	7.5	0.02
-* . .	E. P., Salem, Mass., ...	7.2	0.29
-* . .	E. P., Salem, Mass., ...	7.1	0.45
-* . .	William J. Reineck, Albany, N.Y., ...	6.7	0.27
-* . .	Henry Haussling, Newark (registered), (this bottle not to be sold).	6.7	0.05
Strawberry, .	C. B. W. S. Company, Boston, Mass., ...	6.5	0.30
-* . .	T. B. Barnes, Plymouth, Pa., ...	6.3	0.15
-* . .	C. Hoffmann & Co., Lake View, Ill., ...	5.3	0.15
-* . .	Crystal Spring Soda Works, Meriden, Conn., ...	4.6	0.25
-* . .	——— ———, ...	4.6	0.20
-* . .	John T. Driscoll & Co., Boston, Mass., ...	4.2	0.20
-* . .	Chas. Malatesta, 55 Endicott Street, Boston (registered), .	4.1	0.35
-* . .	Chas. Malatesta, 55 Endicott Street, Boston (registered), .	3.8	0.10
Sarsaparilla, .	Mt. Washington Cold Spring Manufacturing Company, . .	3.5	0.17

* Character of sample not specified.

Besides the above tabulated samples, 20 were found containing less than 3 per cent. of lead. While the amount of lead found in the contents of the bottles was in no case very large, it is enough to condemn the use of lead in the manufacture of such stoppers. That the amounts of lead found in the contents of the bottles vary quite irrespective of the percentage of lead in their stoppers may be ascribed to various causes, such as the difference in the acidity of one and another liquor, and the length of time that the liquor has

been in contact with the stopper. Furthermore, the more soluble metal of a double alloy is attacked by an acid with an energy which is not proportional to the percentage of that metal in the alloy.

Many samples of the cheap jellies have been examined. As is well known, a ten-cent tumbler of so-called currant jelly may contain no currant whatsoever. It is a cheap substitute, made of apple extract, corn syrup, cane sugar, with a little additional acid, such as sulphuric, and sometimes artificial color, usually anilin, and also a little artificial flavoring which bears only an imaginary resemblance to the genuine currant flavor. The apple extract is obtained by boiling the parings and cores of apples, which would otherwise be refuse products of canning establishments. There can hardly be any objection to the sale of such articles on the score of unwholesomeness, and it seems a legitimate use to make of refuse and cheap materials. As will be seen in the following table, several manufacturers have complied with the statute requiring that such goods should be marked "compound," and that the percentages of the constituent ingredients be printed on the label. These restrictions, however, do not entirely eliminate the element of deception. It is evidently unjustifiable to baldly label, in large letters, such an article "currant jelly," even though it be followed by the required modifications. Furthermore, it will be seen that of the ingredients the apple extract is called in the required explanation "fruit juice." This naturally, if not intentionally, leads the unsuspecting to the conclusion that so much pure currant juice has entered into the composition of this so-called "currant jelly." In the following table the percentages of cane sugar and glucose syrup have been estimated from the direct polarization of solutions of the jellies, and from invert polarizations at temperatures of 20° C. and 90° C. The glucose syrup has been estimated roughly, on the supposition that at 20° C. a pure glucose syrup polarizes at 150 on the cane sugar scale. This figure is an average of many polarizations which we have made of glucose syrups to be found in the Boston market. Another grade of glucose syrup is on the market containing more dextrine and polarizing at about 175, but this grade is not used in the manufacture of jellies.

Jellies.

Manufacturer.	Alleged Flavor.	Per Cent. Cane Sugar.	Per Cent. Glucose Syrup.	Remarks.	Statement, if any, on Label.
F. P. Adams, Boston,	Raspberry,	9.0	42.0	No raspberry juice.	* Compound, with percentage of constituent ingredients.
	Raspberry,	4.0	42.0	No raspberry juice.	
	Grape,	13.5	35.3	No grape juice.	
	Currant,	0.0	34.9	No currant juice.	
Whitcher, Pillman & Co., Ayer,	Currant,	13.0	22.3	No currant juice.	
	Currant,	7.0	85.2	No currant juice.	
	Orange,	7.5	77.2	Contains orange oil; no orange juice.	
	Currant,	3.9	79.3	No currant juice.	
Logan, Johnson & Co., Boston,	Peach,	13.0	23.3	No peach juice.	
Oliver Day, Boston,	Quince,	13.0	29.7	No quince juice.	
	Crab-apple,	15.8	63.3	No crab-apple juice.	
	Raspberry,	8.0	44.7	No raspberry juice.	
W. C. Morse & Co., Boston,	Orange,	4.8	58.0	Contains orange oil; no orange juice.	
	Pineapple,	5.6	26.7	No pineapple juice.	
	Raspberry,	7.0	24.0	Raspberry flavor, but no raspberry juice.	
	Currant,	7.0	24.0	Currant flavor, but no currant juice.	
Central Preserving Company, Boston.	Apple,	26.8	24.0	Apple juice.	† Compound, with percentage of constituent ingredients.
	Pineapple,	26.8	22.7	No pineapple juice.	
	Currant,	26.8	22.7	No currant juice.	
	Raspberry,	26.8	22.7	No raspberry juice.	
	Peach,	26.8	24.0	No peach juice.	
	Raspberry,	26.8	23.3	No raspberry juice.	
American Preserving Company, Philadelphia, Pa.	Strawberry,	48.0	27.0	Contains strawberry,	Compound.
	Raspberry,	46.0	20.0	Contains raspberry,	Compound.
	Strawberry,	46.0	20.0	Contains strawberry,	Compound.
	Peach,	30.0	50.0	No peach juice,	Compound.
	Pineapple,	26.0	56.0	No pineapple juice,	Compound.
	Currant,	24.0	42.0	No currant juice,	Compound.
No name,	Apple,	6.0	68.7	Genuine.	
	Peach,	2.7	59.6	No peach juice.	
	Raspberry,	3.0	56.0	No raspberry juice.	
	Grape,	3.0	56.0	No grape juice.	
	Strawberry,	3.0	56.0	No strawberry juice.	
	Currant,	8.3	63.3	No currant juice.	

* Alleged ingredients and per cent.:—

Fruit juice,	.365
Grape sugar,	.385
Cane sugar,	.250
	1.000

† Alleged ingredients and per cent.:—

Fruit juice,	.355
Corn syrup,	.365
Cane sugar,	.280
	1.000

Jellies — Concluded.

Manufacturer.	Alleged Flavor.	Per Cent. Cane Sugar.	Per Cent. Glucose Syrup.	Remarks.	Statement, if any, on Label.
J. Middleby, Jr., Boston,	Raspberry,	21.0	38.0	No raspberry juice.	* Compound, with percentage of constituent ingredients.
	Strawberry,	21.0	30.0	Slight amount strawberry.	
	Currant,	26.0	31.0	Currant flavor.	
Munson & Sons, Baltimore, Md.,	Currant,	12.9	28.0	Genuine.	
Boston Preserving Company, Boston.	Peach,	15.5	73.3	No peach juice.	
	Pineapple,	5.0	73.3	No pineapple juice.	
	Quince,	16.0	78.0	No quince juice.	
	Raspberry,	15.0	62.0	No raspberry juice.	
W. Virginia Preserving Company, Wheeling, W. Va.	Currant,	5.5	66.7	Genuine.	
G. E. Wales, Newton,	Currant,	9.5	None.	Genuine; 62.5 per cent. invert sugar.	

Jams.

McMechen, Wheeling, W. Va.,	Strawberry,	9.0	52.0	Genuine.	
Anderson Preserving Company, Camden, N. J.	Raspberry,	11.3	55.9	Genuine.	
No name,	Gage plums,	8.3	71.2	Genuine.	
Curtice Bros., Rochester, N.Y.,	Strawberry,	18.8	15.9	Genuine.	
	Raspberry,	9.0	67.6	Genuine.	
	Strawberry,	4.8	67.6	Genuine.	
Whitcher, Pillman & Co., Rochester, N. Y.	Damson,	1.8	69.7	Genuine.	
Cowdrey, Boston,	Pineapple,	10.0	50.9	Genuine,	†

* Alleged ingredients and per cent.: —

Fruit juice,	.355
Corn syrup,	.365
Cane sugar,	.280
	1.000

† Made only with fresh fruit and refined sugar.

Summary of Food Statistics.

Foods.	Genuine.	Adulterated.	Total.	Per Cent. of Adulteration.
Allspice,	128	8	136	5.8
Butter,	414	6	420	1.4
Canned goods,	43	5	48	10.5
Cassia,	228	21	249	8.4
Cayenne,	52	16	68	23.5
Cheese,	96	0	96	0.0
Chocolate,	25	13	38	34.2
Cloves,	281	39	320	12.2
Coffee,	140	19	159	11.9
Confectionery,	59	0	59	0.0
Cream of tartar,	397	10	407	2.4
Ginger,	213	30	243	11.9
Honey,	60	28	88	31.8
Lard,	30	3	33	9.1
Mace,	27	3	30	10.0
Maple sugar,	25	8	33	24.2
Maple syrup,	41	11	52	21.1
Miscellaneous,	154	44	198	22.2
Molasses,	279	17	296	5.7
Mustard,	188	85	273	31.1
Nutmeg,	17	2	19	10.5
Olive oil,	14	6	20	30.0
Pepper,	330	30	360	8.3
Syrups,	10	25	35	71.4
Tea,	100	3	103	2.9
Vinegar,	87	74	161	45.9
Totals,	3,438	506	3,944	12.8

Drugs.

Samples which do not conform with the requirements of the Pharmacopœia are here reported adulterated or of poor quality.

Acidum Benzoicum: Six samples, proved of good quality.

Acidum Hydrobromicum Dilutum: Of 7 samples, 3 failed to meet the pharmacopœial requirements.

Acidum Sulphuricum: One sample of the 3 examined contained too much water.

Acidum Sulphurosum: Four of the 5 samples examined were deficient in $S\,O_2$. One sample consisted chiefly of sulphuric acid.

Acidum Tannicum: Two samples proved of good quality.

Æther: Of 25 samples examined, 3 contained too much water and alcohol, and 1 contained a notable admixture of chloroform.

Æther Aceticus: Of 6 samples submitted, 2 were of poor quality, 1 contained 2.6 per cent. of acetic acid.

Alcohol: Of 20 samples examined, 2 contained too much water.

Aloe Purificata: The 2 samples submitted were of good quality.

Aqua Ammoniæ: Of 11 samples examined, 1 was of poor quality. It contained but one-quarter of the proper amount of NH_3.

Aqua Ammoniæ Fortior: Of 11 samples examined, 3 were of insufficient strength.

Aqua Destillata: Of 27 samples submitted, 18 were of poor quality, containing a notable amount of solid matter. The largest amount of residue found was 19 parts per 100,000.

Argenti Nitras: Of 42 samples, 2 were of poor quality.

Bismuthi Subcarbonas: Of 14 samples, 3 were of poor quality.

Bismuthi Subnitras: Of 39 samples, 11 were of poor quality. Several were excessively acid in reaction, while 1 contained a considerable trace of lead.

Calx Chlorata: All of the 18 samples examined were of poor quality.

The percentages of available chlorine found in samples of various brands are shown by the following figures: —

Acme,	21.0	Brookman's High Test,	5.0
"	15.0	" " "	3.0
"	4.0	" " "	1.5
"	3.5	Wm. Archibald,	20.0
"	2.5	Lion,	25.0
"	0.8	"	14.5
"	0.8	"	13.0
Brookman's High Test,	28.0	"	12.5

Capsicum: Of 10 samples of the ground red pepper sold as a drug, only 1 proved of poor quality.

Cera Alba: Of 16 samples, 1 was adulterated with paraffin.

Cera Flava: The 1 sample submitted proved of good quality.

Ceratum: The 5 samples examined were all of good quality.

Cerii Oxalas: The 15 samples examined were all of good quality.

Chloral Hydras: Of 17 samples, 1 proved not up to standard.

Chloroformum: Of 11 samples, 1 proved below standard.

Extractum Glycyrrhizæ: Of 10 samples, 5 were adulterated with corn-starch.

Ferri et Quininæ Citras: Of 24 samples examined, 13 contained too little of the alkaloid.

Ferri et Strychninæ Citras: Five samples were all of good quality.

Glycerinum: The 40 samples examined were all up to standard.

Iodoformum: The single sample examined was of good quality.

Lycopodium: The 1 sample submitted was of good quality.

Oleum Ætheris: The single sample examined was of good quality.

Oleum Limonis: Of 21 samples examined, 10 were below standard strength.

Oleum Olivæ: Of 29 samples examined, 9 were adulterated with seed oil.

Pulvis Glycyrrhizæ Compositus: Of 4 samples examined, 2 were adulterated.

Pulvis Opii: Of 31 samples submitted, 12 contained too little morphine. The following figures show the percentages of morphine found in each sample: —

15.56	14.50	13.80	13.00	12.55	11.80
14.96	14.20	13.71	13.00	12.50	11.70
14.87	13.98	13.70	12.95	12.45	10.90
14.85	13.95	13.70	12.90	12.42	10.73
14.70	13.90	13.50	12.70	12.11	10.65

Spiritus Ætheris Compositus: Of 19 samples examined, 15 failed to meet the requirements. Many of those below the standard contained no etherial oil whatsoever. In one instance amyl alcohol was substituted for etherial oil.

Spiritus Frumenti: Of the 16 samples examined, 11 were below standard. The following figures show the percentages of alcohol by weight and the percentages of solid matter in these samples : —

Alcohol.	Solids.	Alcohol.	Solids.	Alcohol.	Solids.	Alcohol.	Solids.
48.00	0.20	43.14	0.96	41.80	0.40	39.40	0.30
46.46	0.20	43.14	0.85	40.00	0.32	39.00	0.30
46.09	0.20	42.00	0.79	40.00	0.20	38.30	0.90
44.00	0.26	42.29	0.39	39.80	0.17	35.90	0.90

Spiritus Juniperi: Of the 6 samples submitted, 2 were not of the required strength.

Spiritus Vini Gallici: Of 2 samples examined, neither was of pharmacopœial strength.

Succus Limonis: Of 13 samples, only 1 was of standard quality. The poor samples were of the following brands: Crown, Victor (containing salicylic acid, 1 grain per quart), Banner, Folkins (containing salicylic acid, 4 grains per quart), Imperial, London, Stanley, West India (containing salicylic acid, 1 grain per quart), Montego (containing salicylic acid, 4 grains per quart).

A sample of the brand "Santiago W.I. triple refined" was found to consist of a dilute solution of hydrochloric acid flavored with oil of lemon and preserved with salicylic acid. It contained no lime juice whatsoever. It is recommended on the label as specially good for rheumatism.

Syrupus: Of 13 samples, 3 were of insufficient sugar strength.

Tinctura Iodi: Of 23 samples, 20 were below the required strength.

Tinctura Opii: Of 42 samples, 28 were of insufficient strength of morphine. The percentages of morphine found in the various samples are shown by the following figures: —

1.573	1.305	1.163	1.061	0.990
1.453	1.300	1.151	1.060	0.981
1.435	1.253	1.150	1.050	0.979
1.383	1.248	1.116	1.031	0.950
1.380	1.230	1.097	1.013	0.905
1.344	1.218	1.093	1.011	0.895
1.341	1.197	1.090	1.000	0.681
1.340	1.181	1.071	0.994	0.000
1.314	1.176	1.065		

One sample was found to be a tincture of a completely exhausted opium, containing no morphine.

Tinctura Rhei: The single sample examined was not of pharmacopœial strength.

Vinum Album: The 9 samples examined were all of poor quality. The lowest percentage of alcohol found in any sample was 10.38. The highest percentage of solid matter was in the same sample, 18.14.

Vinum Rubrum: None of the 19 samples examined were of pharmacopœial purity. As usual, sugar was the chief adulterant. The lowest percentage of alcohol found was 10.69, while the highest percentage of solid matter was 17.95.

Miscellaneous.

Three samples of gin were examined, all answering the requirements of the dispensatory.

A sample of catarrh powder was composed of milk sugar with sodium bicarbonate, and 2.77 per cent. of cocaine and 1.36 per cent. of menthol.

A sample of headache powder consisted of acetanilid with capsicum and a little tolu for flavor.

A package of malt tablets consisted of sugar lozenges colored brown by the liberal admixture of a ferric oxide. They possessed no diastatic power whatever.

A sample of "Go to Sleep" was found to consist essentially of sulphonal.

A sample of so-called "Boston Drug" for the cure of inebriates consisted essentially of milk sugar 9 parts, and ammonium chloride 1 part.

Three samples of a cheap grade of quinine pills were examined, with the result that all were found of good quality. They showed an equivalent percentage of sulphate of quinine as follows: 91.9, 90.3, 89.4.

A sample of corn cure consisted of tallow and salicylic acid.

Samples of insect exterminators were found on examination to be composed, one of benzine, naphthaline, and a color; another of colored benzine; a third of turpentine and naphtha; and a fourth of sodium oxalate with kaolin.

SUMMARY.

	Genuine.	Adulterated.	Total.	Ratio of Adulteration.
Milk,	3,990	1,850	5,840	31.6
Food not milk,	3,438	506	3,944	12.8
Drugs,	442	248	690	35.9
Totals,	7,870	2,604	10,474	24.9

Respectfully submitted,

CHARLES P. WORCESTER.

WESTERN MASSACHUSETTS.

The milk obtained in the four western counties is examined at the laboratory of the Amherst Agricultural College by Prof. C. A. Goessmann.

The whole number of samples collected in these counties during the year was 220, and the number found to be below the standard was 63, or 28.6 per cent. This percentage is unusually high for the western counties. It would, however, be fair, as was shown in the report of last year, to exclude from the summary those samples, 18 in number, which were obtained from suspected producers. This would leave the percentage of samples below standard 22.2, which is slightly higher than that of any previous year.

The following summary embraces the samples of milk obtained during the year in cities and towns west of Worcester County. The results of analyses were as follows: —

Whole number examined,	220
Number above standard,	157
Number below standard,	63
Percentage below standard,	28.6
Number samples skimmed milk,	22

Holyoke.

Number of samples,	23
Number above standard,	17
Number below standard,	6
Percentage below standard,	26.1
Skimmed milk,	3

North Adams.

Number of samples,	23
Number above standard,	19
Number below standard,	4
Percentage below standard,	17.4
Skimmed milk,	2

Northampton.

Number of samples.	17
Number above standard,	15
Number below standard,	2
Percentage below standard,	11.8
Skimmed milk,	5

The results in the towns were as follows: —

	Total.	Above Standard.	Below Standard.	Percentage below Standard.	Skimmed Milk.
Amherst,	3	1	2	–	1
Buckland,	6	6	0	–	1
Greenfield,	21	17	4	–	2
Northfield,	18	0	18	–	0
Palmer,	8	3	5	–	0
Turner's Falls (Montague),	20	20	0	–	0
Westfield,	27	20	7	–	1
	103	67	36	34.9	5

CHARLES A. GOESSMANN.

REPORT

UPON THE

PRODUCTION AND USE OF DIPHTHERIA ANTITOXIN.

REPORT

UPON THE

Production and Use of Diphtheria Antitoxin,

FOR THE

Twelve Months ending March 31, 1898.

Following the same plan which was begun in the twenty-seventh annual report, this third report upon the production and use of antitoxin embraces the work done in this direction for the year ending March 31, 1898.

The supervision of antitoxin production has been under the charge of Dr. Theobald Smith, assisted by T. R. Stewart, throughout the year. The distribution has been conducted from the office of the Board at the State House.

The strength of the serum issued was maintained at a somewhat higher average standard than that which had been attained in the previous years, while a small amount of a weaker serum was furnished for hospitals and physicians who desired it for the purpose of immunization.

The serum was generally distributed to the boards of health of cities and towns, to contagious disease hospitals and to physicians throughout the State. During the months of July and August, when the serum furnished to the City Hospital by the city board of health proved inadequate, the hospital was supplied by the State Board of Health, and on April 1, 1898, the State Board began supplying the City Hospital regularly. This additional demand greatly increased the amount required of the Board, but at no time has the demand exceeded the supply. The experience and observations of past years have enabled the Board to anticipate the necessities of the different seasons in this particular, so that a sufficient quantity of serum may be produced in the summer, during the time of diminished demand, to provide for the usual increase which has followed upon the advent of cooler weather.

Comment was made in the report of the year upon the increasing favor with which diphtheria antitoxin has been received by the medical profession throughout the State, as shown by the considerably increased demand for it year by year, notwithstanding a diminution in the actual amount of diphtheria existing in the State.

The total number of packages issued by the Board during the three years ending with March 31, 1898, was as follows: —

In 1895–96 (year ending March 31),	1,724 bottles.
In 1896–97 (year ending March 31),	3,219 bottles.
In 1897–98 (year ending March 31),	4,668 bottles.
Total,	9,611 bottles.

As the contents of each package represent 1,000 antitoxin units of serum, the total amount in the three years amounts to nearly 10,000,000 units.

Two reasons account for the increased demand of the past year: one, already stated, the increasing favor with which the remedy has been received; and, secondly, the occasional use by the City Hospital of the antitoxin prepared by the Board. This has now become permanent, in consequence of the discontinuance of the work which was being carried on by the city of Boston for the same purpose.

Further comment was also made in the report of last year upon the comparatively small ratio of reports which have been made relative to the use of the product by physicians. This same comment may also be made with reference to the work of the past year. The reports have greatly exceeded in number those of 1896, but the ratio to the number of cases remains about the same.

Very little is now heard in opposition to the use of antitoxin as compared with that which was manifest during the first year after its introduction. The figures presented in this report speak for themselves so far as the reduction which has taken place in the fatality of diphtheria is concerned. The fatality in the pre-antitoxin period, as shown in past reports of this Board, was 28.3 per cent. for the period of four years, 1891–94, while during the years 1895–97 the general fatality from diphtheria throughout the State was only 16.0 (see page 628 of this report), and for those cases treated with antitoxin it was only 10.7 per cent. (see page 598).

The total amount of diphtheria antitoxin distributed by the Board during the year ending March 31, 1898, was 4,668 bottles, the

strength of which averaged more than 100 units per cubic centimeter, the variability being mainly from 100 to 125 units per cubic centimeter, excepting a small quantity which was produced and issued for the purpose of immunization.

The whole number of cities and towns to which antitoxin was distributed was 114, or 25 more than those which were published in the report of 1896. The actual number in each year was probably somewhat larger than these figures, since a few of the more distant cities acted as distributing centres for small towns in their neighborhood, and in some instances no returns were made from these towns. This serum was distributed to local boards of health and to physicians in the following cities and towns: —

Number of Bottles of Diphtheria Antitoxin distributed from April 1, 1897, to March 31, 1898.

City or Town.	Number Bottles.	City or Town.	Number Bottles.
Boston:		Winchester,	53
Children's Hospital,	289	Wakefield,	47
City Hospital,	378	Attleborough,	46
General supply,	26	Clinton,	43
Cambridge,	274	Chicopee,	42
Waltham,	269	Dedham,	41
School for the Feeble-minded,	166	Belmont,	40
Worcester,	213	Pittsfield,	49
Everett,	189	Amesbury,	36
Peabody,	161	Hyde Park,	35
Somerville,	159	Brockton,	35
Woburn,	150	Haverhill,	34
Fitchburg,	134	Ware,	34
Springfield,	127	Danvers,	34
Lynn,	127	Lawrence,	32
New Bedford,	112	Arlington,	31
Lowell,	99	Winchendon,	25
Chelsea,	85	Quincy,	24
Watertown,	76	Milford,	23
Newton,	75	Marlborough,	22
North Adams,	75	Holbrook,	19
Taunton,	71	Warren,	18
Brookline,	55	Beverly,	18
Malden,	54	Douglas,	18

Number of Bottles of Diphtheria Antitoxin distributed from April 1, 1897, to March 31, 1898 — Concluded.

City or Town.	Number Bottles.	City or Town.	Number Bottles.
Concord,	16	Rowley,	6
Tewksbury,	16	Medfield,	6
Adams,	16	North Attleborough,	5
Medford,	30	Marblehead,	5
Natick,	16	Melrose,	5
Northampton,	15	Hingham,	5
Winthrop,	15	Norwell,	5
Westfield,	15	North Abington,	4
Cohasset,	13	Maynard,	4
Uxbridge,	13	Hull,	4
Newburyport,	12	Northfield,	4
Ayer,	12	Andover,	4
Shirley,	11	Weymouth,	4
Leominster,	11	Rockland,	4
Ipswich,	11	Avon,	4
Milton,	10	Weston,	4
Weymouth,	10	Middleborough,	4
Framingham,	10	Mansfield,	3
Rockland,	10	Williamstown,	3
Abington,	9	Spencer,	3
Westborough,	8	Palmer,	3
Medway,	8	Southampton,	3
Marblehead,	8	Hudson,	3
Monson,	7	Randolph,	3
Bedford,	7	Ashland,	3
Southborough,	7	Westford,	3
Foxborough,	7	West Brookfield,	3
Hardwick,	7	Lexington,	3
Norton,	6	Wales,	2
Norwood,	6	Falmouth,	2
West Springfield,	6	Pembroke,	2
Gardner,	6	Stoneham,	2
East Bridgewater,	6	Georgetown,	1
Holyoke,	6	Reading,	1
North Brookfield,	6	Petersham,	1
Holliston,	6	Total,	4,668
Brookfield,	6		

The following list presents the names of the cities and towns from which detailed reports were received relative to the use of antitoxin, with the number from each town and the number of physicians reporting in each during the year ending March 31, 1898 : —

List of Cities and Towns from which Reports have been received relative to the Use of Antitoxin in the Treatment of Diphtheria, with the Number of Reports from Each and the Number of Physicians reporting in Each.

PLACES.	Number Physicians reporting.	Cases in which Cultures were made.	Cultures were not made.	PLACES.	Number Physicians reporting.	Cases in which Cultures were made.	Cultures were not made.
Abington,	1	-	1	Hardwick,	1	-	3
Adams,	3	6	14	Haverhill,	6	3	7
Agawam,	1	-	1	Holliston,	1	-	1
Amesbury,	2	-	10	Hyde Park,	1	1	3
Arlington,	5	9	6	Lawrence,	5	-	5
Attleborough,	5	7	11	Leominster,	2	3	1
Avon,	1	-	3	Lexington,	1	-	1
Ayer,	1	-	1	Lowell,	14	16	3
Bedford,	1	1	1	Lynn,	2	5	4
Belmont,	1	8	-	Contagious Dis. Hospital,	-	22	14
Blackinton,	1	1	-	Malden,	3	-	7
Boston,	3	5	1	Mansfield,	1	1	-
City Hospital,	-	126	2	Medford,	5	7	3
Bradford,	1	-	1	Milford,	2	-	3
Brockton,	2	-	5	Millbury,	2	5	3
Cambridge,	5	10	3	Natick,	6	6	2
Chelmsford,	1	-	1	New Bedford,	10	9	11
Chelsea,	5	11	3	Newburyport,	3	3	1
U. S. Marine Hospital,	-	2	-	Newton,	3	11	-
General Hospital,	-	10	1	North Adams,	6	7	7
Chicopee,	1	-	3	North Brookfield,	1	-	1
Clinton,	1	1	-	Norton,	1	4	9
Cohasset,	1	1	1	Palmer,	1	-	1
Dalton,	1	-	1	Peabody,	5	1	25
Danvers,	4	13	2	Pittsfield,	2	1	2
Everett,	6	22	9	Quincy,	4	2	2
Fitchburg,	13	36	16	Randolph,	1	-	1
Framingham,	1	1	2	Reading,	1	1	-
Gardner,	1	-	1	Rowley,	1	1	-

List of Cities and Towns from which Reports have been received relative to the Use of Antitoxin in the Treatment of Diphtheria, with the Number of Reports from Each and the Number of Physicians Reporting in Each — Concluded.

Places.	Number Physicians reporting.	Cases in which Cultures were made.	Cultures were not made.	Places.	Number Physicians reporting.	Cases in which Cultures were made.	Cultures were not made.
Somerville,	4	7	7	Westborough,	1	1	1
Springfield,	18	15	40	Westford,	1	1	-
Stoneham,	1	-	3	Weymouth,	2	-	2
Taunton,	5	-	10	Williamstown,	1	-	1
Wakefield,	1	-	9	Winchester,	4	9	7
Waltham,	4	9	5	Woburn,	8	18	91
City Hospital,	-	22	3	Worcester,	15	67	2
School for Feeble-minded,	-	18	1	Wrentham,	1	1	-
Ware,	3	1	9	Total,	235	569	417
Watertown,	7	21	6				

Cases in which a Bacterial Examination was made.

Following the same method of classification which was adopted in the report of the two previous years, the cases in which cultures were made are classified into those which proved on examination to be cases of genuine diphtheria and those which did not; in other words, into positive and negative cases.

Diagnostic examinations by means of culture were made in 558 of the cases reported, and of these, 502 proved to be cases of genuine diphtheria and 56 gave a negative result.

Positive Cases.

Of the 502 positive cases, there were 461 recoveries and 41 deaths, or 8.2 per cent., — an improvement over the results of the two previous years, which were 11.6 and 13.7 per cent.

Sex. — The number of males was 223, and the deaths of these were 17, or 7.6 per cent., which was scarcely half as great as the 14.5 per cent. of the previous year. The females were 266, and the deaths of these were 23, or 8.7 per cent., as compared with 8.9 per cent. in 1896. The sex of 13 was not stated. One death.

Ages. — The following table presents the cases and deaths by ages : —

Year ending March 31, 1898.

Age Periods.	Cases.	Deaths.	Fatality (Per Cent.).	
			1897.	1896.
From 0 to 2 years, . . .	58	7	12.1	17.6
From 2 to 5 years, . . .	152	17	11.2	14.3
From 5 to 10 years, . . .	147	12	8.2	14.9
Over 10 years, ...	136	5	3.7	5.0
Age unknown, ...	9	0	0.0	0.0
	502	41	8.1	11.6

Of those who were more than ten years of age, 78 were between ten and twenty, 42 were between twenty and thirty, 19 were between thirty and forty, 11 were between forty and fifty, 1 was fifty-five, 1 was sixty-four, 1 was sixty-eight and 1 was seventy-eight. Of the fatal cases in this class, 1 was thirty-five, 1 was forty-five, 1 was sixty-four and 1 was seventy-eight.

Day of Illness when Antitoxin was first administered. — The following table presents the fatality, according to the day of illness on which antitoxin was first administered : —

Day.	Cases.	Deaths.	Fatality (Per Cent.).		
			1897.	1896.	1895.
First, ...	50	4	8.0	0.0	0.0
Second, ...	101	9	8.9	9.5	9.7
Third, ...	100	7	7.0	8.3	8.7
Fourth, ...	67	2	3.0	22.7	15.4
Fifth, ...	34	4	11.8	0.0	22.2
Sixth, ...	13	0	0.0	14.3	20.0
Seventh, ...	10	3	30.0	25.0	33.3*
Eighth and later, .	22	3	13.6	16.6	–

* Seventh day and later.

This table relates only to those cases in which a definite statement is given as to the day on which the antitoxin was first employed.

The small numbers in the lower part of this table have but little significance as compared with the larger numbers. They are retained, however, with the hope that the grouping of several years' experience will prove more valuable.

Fatality in Hospital and in Private Practice. — The fatality of the positive cases treated in hospitals are as follows: cases, 164; deaths, 15 = 8.6 per cent. In private practice: cases, 328; deaths, 26 = 7.9 per cent.

Seasons of the Year. — The cases embraced in the foregoing enumeration occurred in the following order: —

Months.	Cases.	Deaths.	Months.	Cases.	Deaths.
1897.			**1897.**		
April,	11	1	October,	62	4
May,	29	5	November,	58	2
June,	13	1	December,	63	4
July,	65	7			
August,	93	9	**1898.**		
September,	27	1	January,	47	4
			February,	9	1
			March,	21	2
	238	24		260	17
			Date unknown,	4	-

By this table it appears that there were 238 cases and 24 deaths among positive cases in the warmer months, and 260 cases with 17 deaths in the colder months.

Negative Cases.

The number of cases in which a negative result was obtained was 56. There were 4 deaths among these 56 negative cases, or 7.1 per cent.

Summary of the Three Years, ending March 31, 1898.

Positive Cases treated with Antitoxin.

Whole number for the three years, 953; deaths, 99; fatality, 10.4 per cent.

Sex. — The fatality by sexes was as follows: —

Sex.	Cases.	Deaths.	Fatality (Per Cent.).
Males,	424	46	10.9
Females,	510	49	9.6

The sex of 19 was not stated. One death.

Ages. — The fatality by ages was as follows: —

Age Periods.	Cases.	Deaths.	Fatality (Per Cent.).
0 to 2 years,	105	19	18.1
2 to 5 years,	286	42	14.7
5 to 10 years,	285	28	9.8
Over 10 years,	263	10	3.8
Age unknown,	14	0	0.0
	953	99	10.4

Hospitals and Private Practice.

	Cases.	Deaths.	Fatality (Per Cent.).
In hospitals,	298	32	10.7
In private practice,	653	67	10.3

Cases in which no Bacteriological Examination was made during the Year ending March 31, 1898.

Reports were made of 444 cases where antitoxin was employed, in which no cultures were taken. Out of this number there were 49 cases which proved fatal, or 11 per cent. of the whole. This number differs but little from those of 1895 and 1896 for the same class of cases, which were, respectively, 11.7 and 11.2 per cent. There were, however, 3 of the cases which occurred in this class in 1897 which may properly be rejected from consideration, since the patient was at the point of death in each case at the time of administration of the antitoxin. The following terms were employed in the returns in describing these cases: "beyond help," "practically moribund," and "past recovery" when first seen by attending physician. It would, therefore, be proper to reject such cases as being beyond the power of remedial agencies of any sort.

Sex. — The number of males in this class was 195, and the deaths of these were 22, or 11.3 per cent. The number of females was 232, and the deaths of these were 22, or 9.5 per cent. The number of those whose sex was unknown or not stated was 17, and there were 5 deaths of these.

Ages. — The following table presents the cases and fatality by ages: —

Age Periods.	Cases.	Deaths.	Fatality (Per Cent.).
From 0 to 2 years,	53	10	18.8
From 2 to 5 years,	140	16	11.4
From 5 to 10 years,	144	15	10.4
Over 10 years,	96	6	6.3
Age unknown,	11	2	18.2
	444	49	11.0

Day of Illness when Antitoxin was first administered.

The cases and deaths, distributed according to the day of illness when antitoxin was first administered among this group of cases, are presented in the following table: —

Day of Illness when Antitoxin was first administered.

Day.	Cases.	Deaths.	Fatality (Per Cent.).
First,	108	7	6.5
Second,	93	6	6.5
Third,	55	4	7.3
Fourth,	27	8	29.6
Fifth,	17	3	17.6
Sixth,	8	3	37.5
Seventh and later,	13	2	15.4
Unknown,	123	16	13.0
	444	49	11.0

Hospitals and Private Practice.

The fatality among the private and hospital cases of this class was as follows: —

	Cases.	Deaths.	Fatality (Per Cent.).
Treated in hospitals,	35	3	8.6
Treated in private practice,	409	46	11.2
Total,	444	49	11.0

Sequelæ.

In this summary all cases are considered together, those in which cultures were made and those in which none were made.

Eruptions. — Urticaria was reported as occurring in 130 cases, of varying severity and at greater or less intervals from the time of administration of antitoxin. In 21 cases it was "copious," or generally distributed over the body; and in the remainder its severity was either "slight," "local" or was not specified. It usually lasted from two to five days.

Albuminuria was reported in 152 cases. In 126 it was reported as "slight," or a "trace" only, or the character was not stated; in 26 it was severe.

In 10 cases rheumatic pains and joint affections were reported.

In 11 cases paralysis of the throat was reported.

Two cases were reported as being complicated with scarlet-fever and one with pneumonia, the latter proving fatal.

Operations.

Of the foregoing cases, there were 40 in which operative interference was deemed necessary, and of these there were 37 in which intubation was performed, 10 of which proved fatal. One of these was intubated on the first day of illness, 6 on the second, 4 on the third, 4 on the fourth, 3 on the fifth, 1 on the sixth, 1 on the eighth, and the time was not stated in 17 cases. In 1 case intubation was performed five times, the patient recovering.

Tracheotomy was performed in 3 instances, 2 of which were fatal.

The Brands of Antitoxin employed.

Since this report deals mainly with the antitoxin produced and offered for use to the local boards of health by the State Board of Health, it follows that the returns received upon the blank forms supplied by the Board present the results of its use. In a few instances, however, returns were received from parties who had, through inability to obtain the product supplied by the Board, or for other reasons, employed other brands, and in a very few cases two different brands were used in the treatment of single cases.

In the last annual report a summary of the statistics of fatality from diphtheria in certain other States and countries was presented, comprising about 20,000 cases. Very much additional testimony of the same kind might be added this year, the accumulation of which all tends to show the value of diphtheria antitoxin. The publication

of such material, however, is now scarcely necessary, since the medical profession as a whole may be said to have adopted the remedy as one of the most important additions to the list of therapeutic agents.

The following statement, published in the last annual report for 1896, applies equally to the results of the year 1897 : —

> It is quite plain that a comparison of the fatality of cases treated with antitoxin with the general fatality of cases of diphtheria previous to the introduction of this therapeutic agent, or even with cases not treated with antitoxin, which occurred at the same period with those so treated, does not do justice to the merits of antitoxin, for the reason that such a comparison must be made between two groups or classes of cases which are not strictly comparable, since one contains a larger and the other a smaller percentage of severe cases. That is to say, the general run of cases treated with antitoxin by physicians in private practice, and especially of those sent to hospital, must necessarily be a selected class, in which the percentage of severe cases is greater than it is in the whole number of cases of diphtheria occurring or reported in a given community.
>
> It has been urged, and with some degree of reason, that the diminution in the fatality from diphtheria is partly due to the introduction of bacterial diagnosis by means of cultures from the throat, whereby mild cases of illness are shown to be cases of true diphtheria which would otherwise have passed unnoticed. But this statement is in some measure offset by the fact that a considerable number of cases which might have passed for diphtheria before the days of bacterial diagnosis are now classed as "negative."
>
> The present report gives support to the belief that the value of this argument has been over-estimated, since the cases in which cultures were made are here separated from those in which they were omitted, and the fatality in each group differs but slightly. This fact does not, however, in the least degree undervalue the importance of having a careful diagnosis made by means of cultures in each case, either before the administration of antitoxin, or as soon as possible after the beginning of treatment.
>
> The most important lesson which is taught by these returns is the necessity of *early administration of the antitoxin in each and every case.*

Out of 294 cases in which antitoxin was administered on the first day of illness there were only 13 deaths, or 4.4 per cent. ; and out of 711 cases treated during the first two days of illness there were only 46 deaths, or 6.5 per cent. ; while the deaths in 156 cases in which antitoxin was not employed until the sixth and seventh days and later were 30, or 19.2 per cent., the patients in the former instances having a chance of living three times as great as in the latter.

General Summary, 1895, 1896 and 1897.

Positive cases treated in the three years ending March 31, 1898,	953
Cases in which no bacteriological examination was made, .	982
	1,935*
Deaths of these, ...	207
Fatality (per cent.), ...	10.7

Sexes.

The number of males who were treated was †	853
The number of females who were treated was †	1,027
The number whose sex was not stated was †	55
Total, ...	1,935*
Deaths of males, ...	96
Fatality of males (per cent.), ...	11.2
Deaths of females, ...	101
Fatality of females (per cent.), ...	9.8
Deaths, sex not stated, ...	10

Deaths by Ages.

Age Periods.	Cases.	Deaths.	Fatality (Per Cent.).
0 to 2 years, ...	196	37	18.9
2 to 5 years, ...	580	83	14.3
5 to 10 years, ...	621	61	9.8
Over 10 years, ...	496	22	4.4
Age unknown or not stated, ...	42	4	9..5
Total, ...	1,935	207	10.7

Day of Administration.

Day.	Cases.	Deaths.	Fatality (Per Cent.).
First, ...	294	13	4.4
Second, ...	417	33	7.9
Third, ...	313	26	8.3
Fourth, ...	238	36	15.1
Fifth, ...	101	15	14.9
Sixth, ...	59	12	20.4
Seventh and later, ...	97	18	18.5
Unknown, ...	354	50	14.1

* In this number (1,935) 99 cases in which a bacterial diagnosis showed negative results are not included, so that the whole number treated with antitoxin of which returns were made to the Board was 2,034.

† Except cases determined to be "negative."

Diphtheria Cultures examined during the Year ending March 31, 1898.

Bacteriological Diagnosis of Diphtheria for the Year ending March 31, 1898.

During the past year bacteriological examinations have been made of 2,204 cultures from 90 different towns and cities in the State. Of these cultures, 1,260 were for diagnosis and 944 for release from quarantine. The source of these cultures in the State and the results of the examinations are given in the following table: —

Place.	Cultures examined for Diagnosis.			Cultures examined for Release from Quarantine.	Whole Number of Cultures examined.
	Positive.	Negative.	Doubtful.		
Adams,	21	8	–	10	39
Arlington,	6	11	–	15	32
Attleborough,	11	10	–	–	21
Ayer,	1	–	–	–	1
Bedford,	2	–	–	–	2
Belmont,	7	3	–	9	19
Berlin,	1	–	–	–	1
Beverly,	6	15	–	11	32
Boston,	3	1	–	3	7
Bradford,	1	–	–	–	1
Brockton,	1	3	–	–	4
Brookfield,	2	2	–	1	5
Brookline,	–	1	–	–	1
Cambridge,	2	1	–	–	3
Chelmsford,	–	–	2	–	2
Chelsea,	29	21	2	42	94
Cheshire,	1	1	–	–	2
Clinton,	4	7	2	5	18
Cohasset,	1	6	–	4	11
Danvers,	18	21	–	50	89
Dedham,	–	1	–	–	1
Douglas,	1	1	–	1	3
Dover,	–	1	–	–	1
East Bridgewater,	1	1	–	–	2
Everett,	53	49	–	225	327
Fairhaven,	4	2	–	–	6
Fitchburg,	54	38	–	121	213
Hanover,	–	3	–	–	3

Place.	Cultures examined for Diagnosis.			Cultures examined for Release from Quarantine.	Whole Number of Cultures examined.
	Positive.	Negative.	Doubtful.		
Hardwick,	1	1	–	–	2
Harvard,	–	1	1	–	2
Haverhill,	9	15	–	1	25
Hingham,	10	12	–	54	76
Holbrook,	2	–	–	–	2
Hull,	1	2	1	–	4
Hyde Park,	2	10	–	31	43
Ipswich,	2	–	–	–	2
Lancaster,	1	–	–	–	1
Lawrence,	3	5	–	–	8
Leominster,	1	3	–	–	4
Lexington,	2	2	–	1	5
Lynnfield,	–	1	–	–	1
Malden,	6	9	3	7	25
Mansfield,	2	1	–	1	4
Marblehead,	1	7	–	1	9
Marlborough,	–	4	–	–	4
Marshfield,	–	1	–	–	1
Maynard,	6	4	1	–	11
Medfield,	2	5	–	4	11
Melrose,	–	1	1	–	2
Middleborough,	2	1	–	–	3
Milford,	1	1	–	–	2
Milton,	5	12	–	32	49
Monson,	1	2	–	–	3
New Bedford,	29	46	2	56	133
Newburyport,	17	25	–	4	46
Newton,	1	–	–	–	1
North Adams,	16	13	–	45	74
North Attleborough,	4	3	2	5	14
North Brookfield,	1	–	–	1	2
Norton,	4	1	–	–	5
Peabody,	13	5	2	8	28
Pittsfield,	3	1	–	5	9
Quincy,	2	5	–	1	8
Reading,	2	1	–	–	3
Rockland,	2	5	1	2	10
Rowley,	3	–	1	–	4
Salem,	–	1	–	1	2
Somerville,	43	57	4	29	133
South Acton,	–	1	–	–	1
Southborough,	6	5	–	1	12
South Weymouth,	–	4	–	–	4
Spencer,	1	1	–	–	2
Sterling,	2	–	–	–	2
Stoneham,	3	1	1	1	6
Taunton,	–	8	2	2	12
Tewksbury,	3	38	–	–	41
Wakefield,	7	9	–	1	17
Ware,	3	1	–	–	4
Warren,	8	9	–	18	35
Watertown,	28	24	1	64	117
Westborough,	1	–	–	–	1
West Boylston,	–	–	1	1	2

Place.	Cultures examined for Diagnosis.			Cultures examined for Release from Quarantine.	Whole Number of Cultures examined.
	Positive.	Negative.	Doubtful.		
West Brookfield,	3	–	–	–	3
Westford,	–	2	–	–	2
Williamstown,	–	1	–	–	1
Winchendon,	9	11	1	–	21
Winchester,	34	30	–	67	131
Winthrop,	–	4	1	–	5
Woburn,	13	8	2	–	23
Wrentham,	1	–	–	–	1
State,	571	655	34	944	2,204

The Relation of Clinical to Bacteriological Diagnosis.

In the two following tables is given a comparison of the clinical and bacteriological diagnoses of all cases examined for diagnosis during the two years ending March 31, 1897, and March 31, 1898, respectively.

In the clinical diagnoses, only unqualified statements of diphtheria or non-diphtheria are included as positive or negative diagnoses, all qualified statements being classed as doubtful. In the bacteriological diagnoses cultures showing excessive dryness of the culture medium, contamination or scantiness of growth are considered doubtful and excluded in calculating percentages. In negative laryngeal cases with a positive clinical diagnosis a second culture was always requested. The possibility of error in the bacteriological diagnosis is thus reduced to a minimum.

In these tables an attempt is made to show the true value of the bacteriological diagnosis to the physician and to the public health, both in deciding doubtful cases and in controlling the clinical diagnosis.

For the Year ending March 31, 1897.

Clinical Diagnosis.	Bacteriological Diagnosis.			Percentage of Error in Clinical Diagnosis.
	Positive.	Negative.	Doubtful.	
Positive, 356 cases,	239	115	2	32.4
Negative, 140 cases,	27	108	5	19.2
Doubtful, 177 cases,	70	104	3	–
Not given, 205 cases,	109	91	5	–

For the Year ending March 31, 1898.

Clinical Diagnosis.	Bacteriological Diagnosis.			Percentage of Error in Clinical Diagnosis.
	Positive.	Negative.	Doubtful.	
Positive, 502 cases, ...	338	156	8	31.5
Negative, 231 cases, ...	57	176	6	24.4
Doubtful, 241 cases, ...	97	137	7	–
Not stated, 261 cases, ...	108	143	10	–

Persistence of Diphtheria Bacilli in the Throats of Patients Convalescent from Diphtheria.

Here are included only cases in which cultures were made at frequent intervals until a negative result was obtained. The time of persistence is given from the date of the earliest symptoms of disease.

Bacilli were last found,—

At the end of 1 week in	3 cases.
At the end of 1½ weeks in	9 "
At the end of 2 weeks in	18 "
At the end of 2½ weeks in	26 "
At the end of 3 weeks in	34 "
At the end of 3½ weeks in	13 "
At the end of 4 weeks in	25 "
At the end of 4½ weeks in	14 "
At the end of 5 weeks in	7 "
At the end of 5½ weeks in	8 "
At the end of 6 weeks in	9 "
At the end of 6½ weeks in	1 "
At the end of 7 weeks in	5 "
At the end of 7½ weeks in	1 "
At the end of 8 weeks in	3 "
At the end of 9 weeks in	1 "
At the end of 9½ weeks in	1 "
At the end of 11½ weeks in	2 "
At the end of 13 weeks in	2 "
At the end of 21 weeks in	1 "
Average, ...	3.95 weeks.

In the foregoing table the period given is calculated only to the date when the bacilli were last found. Since cultures were rarely made oftener than once a week and often only at

longer intervals, the length of time given falls below the actual length of time during which bacilli were present in the throat of the patient.

This average of four weeks for the persistence of virulent diphtheria bacilli in the throats of convalescent patients, and their occasional persistence for several months after complete recovery make it evident that the bacteriological examination of cultures before release from quarantine is as important to the public health as the examination made for diagnosis of the disease.*

---

* For investigations on the virulence of bacilli persisting in the throat after recovery, see the Twenty-eighth Annual Report for 1896, p. 651.

EXAMINATIONS OF SPUTUM AND OTHER MATERIAL SUSPECTED OF CONTAINING THE BACILLI OF TUBERCULOSIS.

The examinations of material for suspected tuberculosis, which were begun in 1896, have been continued throughout 1897, and the whole number of specimens examined was nearly twice as great as that of the previous year, although it was not large in either year. This department of the work of the bacteriological laboratory has proved very useful as a means of diagnosis and of confirming clinical observations, and rendering the service of the attending physician more certain and more satisfactory.

Suitable packages are furnished by the Board for transmitting the sputum or other material. The experience of the past year renders it imperative that certain points should be observed by all who avail themselves of the facilities which the Board furnishes.

1. The blank forms which accompany the specimens should be filled carefully, and each inquiry answered as far as possible.

2. No sputum or other infectious material should be sent by mail. Samples sent by mail subject the sender to a heavy penalty.

3. The greatest care should be taken that the contents of the bottles cannot possibly leak out.

If the foregoing directions are not complied with, the specimens will be rejected, and will not be examined.

The following tables present the results of examination of sputum and other material forwarded to the Board from different cities and towns for the purpose of determining the presence or absence of the bacilli of tuberculosis.

The whole number of specimens examined was 236, and the results were as follows: —

Tabular Statement of Examinations made by the Board for determining the Presence or Absence of the Bacilli of Tuberculosis in Sputum or Other Material presented for Such Examination.

Town.	Number of Cases examined.	Males.		Females.		Sex not Stated.	
		Positive.	Negative.	Positive.	Negative.	Positive.	Negative.
Adams,	16	2	4	6	4	–	–
Arlington,	3	–	3	–	–	–	–
Attleborough,	5	2	1	1	1	–	–
Boston,	5	1	–	3	–	–	1
Brockton,	8	3	1	1	1	1	1
Boylston,	2	1	–	–	1	–	–
[Bryantville],	1	–	–	1	–	–	–
Brookfield,	3	1	–	1	1	–	–
Braintree,	1	1	–	–	–	–	–
Bradford,	4	–	1	–	2	1	–
Beverly,	1	–	–	1	–	–	–
Canton,	1	–	1	–	–	–	–
Cambridge,	8	–	3	1	4	–	–
Chelsea,	6	–	2	–	4	–	–
Clinton,	1	–	–	–	1	–	–
Danvers,	9	3	2	2	2	–	–
Dedham,	1	–	–	1	–	–	–
Everett,	12	2	2	5	3	–	–
Fairhaven,	3	–	1	–	2	–	–
Franklin,	2	1	–	–	1	–	–
Framingham,	6	3	2	–	1	–	–
Foxborough,	3	–	1	1	1	–	–
Holbrook,	3	1	–	1	1	–	–
Hanover,	1	–	1	–	–	–	–
Haverhill,	5	1	–	2	2	–	–
Hyde Park,	1	–	–	1	–	–	–
Lynn,	1	–	–	–	1	–	–
Marlborough,	6	2	1	2	–	–	1
Malden,	2	–	1	1	–	–	–
Medford,	1	1	–	–	–	–	–
Newton,	1	–	–	–	1	–	–
Norwood,	2	–	–	1	1	–	–
New Bedford,	41	9	10	11	10	–	1
Petersham,	2	–	1	–	1	–	–
Quincy,	2	1	–	–	1	–	–
Rockland,	15	5	5	2	3	–	–
Reading,	1	–	–	–	1	–	–
Stoneham,	2	–	1	–	1	–	–
Somerville,	4	2	–	–	2	–	–
Spencer,	3	1	–	2	–	–	–
Taunton,	1	–	–	–	1	–	–
Warren,	2	1	1	–	–	–	–
Wakefield,	1	–	1	–	–	–	–
Watertown,	8	2	2	2	2	–	–
Weymouth,	7	1	1	–	2	2	1

Tabular Statement of Examinations made by the Board for determining the Presence or Absence of the Bacilli of Tuberculosis in Sputum or Other Material presented for Such Examination — Concluded.

Town.	Number of Cases examined.	Males.		Females.		Sex not Stated.	
		Positive.	Negative.	Positive.	Negative.	Positive.	Negative.
Winchester,	6	–	1	1	4	–	–
Woburn,	5	1	2	1	1	–	–
Wrentham,	1	–	–	–	1	–	–
Westford,	6	1	2	2	1	–	–
Winthrop,	2	1	–	–	1	–	–
Winchendon,	3	–	–	1	1	1	–
Total,	236	50	54	54	68	5	5

Distribution by Ages.

	Number of Cases Examined.	Positive.	Negative.
Between age of 1–10,	8	–	8
Between age of 10–20,	22	8	14
Between age of 20–30,	73	46	27
Between age of 30–40,	54	23	31
Between age of 40–50,	34	13	21
Between age of 50–60,	14	6	8
Between age of 60–70,	9	2	7
Between age of 70–80,	5	1	4
Age not stated,	17	8	9
Total,	236	107	129

Distribution by Sexes.

	Total.	Males.	Females.	Sex not Stated.
Number of cases examined (positive),	109	50	54	5
Number of cases examined (negative),	127	54	68	5
Total,				236

Summary of the Two Years ending March 31, 1898.

Sexes. — The total number examined in the two years was 360, and of these, 157 were males, 180 were females and the sex of 23 was not stated.

Ages. — Of the whole number examined 43 were under twenty years of age; 235, or 75.6 per cent. of those whose ages were known, were between twenty and fifty years, and 33 were over fifty.

Of the specimens from persons who were under thirty years of age, 51.3 per cent. contained the bacilli of tuberculosis, and of those from persons who were over thirty only 41.6 per cent. contained such bacilli.

MALARIA.

The facilities offered to the physicians of the State in the diagnosis of malaria have been continued during the present year. In all, 74 sets of blood films were received for examination. Deducting 2, which were so poorly prepared as to be unfit for microscopic examination, there remain 72. In 32 of these, or 44 per cent., the malarial parasite was found. The distribution throughout the State is given in the following table: —

Towns.	Number of Patients.	Positive.	Negative.	Towns.	Number of Patients.	Positive.	Negative.
Ashland, . . .	1	-	1	North Adams, .	1	-	1
Billerica, . . .	1	-	1	Northborough, .	1	-	1
Boston, . . .	2	1	1	South Berlin, . .	2	2	-
Boylston, . . .	1	-	1	Southborough, .	8	4	4
Clinton, . . .	6	5	1	Uxbridge, . .	31	13	18
Dorchester, . .	2	-	2	Wellesley Farms, .	1	1	-
Everett, . . .	1	-	1	Winchester, . .	1	-	-*
Hyde Park, . .	3	1	2	Winthrop, . .	1	-	1
Lowell, . . .	1	-	1	Woburn, . . .	1	1	-
Marlborough, . .	6	4	2	Total, . .	72	32	40
Mattapan, . . .	1	-	1				

* Doubtful.

So far as can be learned from the blood films, the tertian parasite is the only one which has thus far invaded the State. Crescents belonging to the irregular (æstivo-autumnal) type have not been seen since the beginning of the work. A certain amount of doubt must necessarily rest upon this generalization, as a single examination of the blood cannot be definitely relied upon to determine the character of the parasite.

The large proportion of cases in which the parasite was not detected is due to the causes mentioned in the last report. In some of the presumably malarial cases in which parasites were not found quinine had been administered before the films were made. In a considerable number of cases the sender was himself not inclined to regard the case as one of malaria, but hoped to get some light from the microscopical examination of the blood. In several instances there was doubt between typhoid and malaria. No information was received, however, concerning the subsequent course of the disease.

Owing to the generally meagre information at our disposal, an analysis of the cases would be profitless at the present time. We strongly urge physicians living in regions where malaria is prevalent to carry with them the small cases containing cover-slips provided by the Board, so that the films may be prepared at the very outset, before any quinine is given. This precaution would probably ensure more accurate diagnoses than are now possible.

STATISTICAL SUMMARIES

OF

DISEASE AND MORTALITY.

STATISTICAL SUMMARIES OF DISEASE AND MORTALITY.

The statistical information received by the Board during each year, either through the medium of voluntary returns or in consequence of legal requirements, has, in the last three reports of the Board, been presented under four different heads or groups, which were summarized and defined in the last report as follows: —

1. *The Weekly Mortality Returns.* — These consist of the reports of deaths, which are made up weekly and are sent to the office of the State Board by the registration officials of cities and towns. They are voluntary, and serve principally to show the seasonal prevalence of each of the chief infectious diseases, and the mortality of children under five years old in weekly periods. This series of statistics has been continued by the Board for more than twenty years, and has been published as a summary for fifteen years.

2. *The Reports of Certain Infectious Diseases, — Diphtheria and Croup, Scarlet-fever, Typhoid Fever and Measles.* — These are obtained from the annual reports of local boards of health for the year 1897, which are forwarded to the State Board from cities and towns. By comparing the numbers of reported cases with the reported deaths, the mean fatality of each disease in the places from which the reports are made is obtained with a reasonable degree of accuracy.

3. *Reports of Cities and Towns, made under the Provisions of Chapter 302 of the Acts of 1893.* — By this act each local board of health is required to report to the State Board every case of "disease dangerous to the public health" which is reported to the local board. A digest of these reports is presented in summary No. III.

4. *Reports made under the Provisions of Chapter 218 of the Acts of 1894.* — The full reports of deaths occurring in each city and town having over 5,000 inhabitants comprise another series of returns, which are summarized in No. IV. These reports are made under the requirements of the following statute: —

[ACTS OF 1894, CHAPTER 218, SECTION 3.]

"In each city and town having a population of more than five thousand inhabitants, as determined by the last census, at least one member of said board shall be a physician, and the board shall send an annual report of the deaths in such town to the State Board of Health. The form of such reports shall be prescribed and furnished by the State Board of Health."

I.

Summary of the Weekly Mortality Reports from Cities and Towns.

The following summary comprises the returns of deaths made at the end of each week by the town clerks, city registrars and other officials having in charge the vital statistics of cities and towns.

These returns are compiled each week and published as a bulletin, one copy of which is sent to the registering officer of each city and town in the State. These reports are necessarily incomplete, since they are voluntary, and comprise the mortality statistics of a part of the population only, the reporting places being chiefly the cities and larger towns. The value of the weekly mortality returns consists very largely in the fact that they constitute a continuous history of the prevalence of the principal infectious diseases throughout the State, so far as can be learned from the mortality which they cause.

In connection with the results of the information obtained as a consequence of the enactment of chapter 302 of the Acts of 1893, these weekly mortality reports furnish to the Board an important index of the health of the people, as influenced by the prevalence of epidemic diseases at different seasons of the year. The estimated population of the cities and towns contributing to the returns of 1897 was about 1,533,700, or about three-fifths of the total population.

The data embraced in this summary are the following: —

Average height of barometer for each week.
Mean maximum temperature.
Mean minimum temperature.
Rainfall expressed in inches.
Total deaths reported for each week.
Deaths of children under five years.
Deaths from infectious diseases.
Deaths from consumption.
Deaths from acute lung diseases.
Deaths from typhoid fever.
Deaths from diarrhœal diseases.
Deaths from scarlet-fever.
Deaths from measles.
Deaths from diphtheria and croup.
Deaths from puerperal fever.
Deaths from whooping-cough.
Deaths from malarial fever.
Deaths from small-pox.
Deaths from erysipelas.
Deaths from cerebro-spinal meningitis.

The following table contains a summary of the statistics compiled from these weekly returns of mortality: —

Summary.

1897.	Barometer.	Mean Maximum Thermometer for Each Week.	Mean Minimum Thermometer for Each Week.	Humidity.	Rainfall, in Inches.*	Total Deaths.	Deaths under Five Years of Age.	Consumption.	Acute Lung Diseases.	Typhoid Fever.	Diphtheria and Croup.	Scarlet-fever.	Measles.	Diarrhœal Diseases.	Whooping-cough.	Malarial Fevers.	Small-pox.	Puerperal Fever.	Erysipelas.	Cerebro-spinal Meningitis.
Jan. 9,	30.11	43	27	77	-	599	163	70	111	9	38	8	7	4	1	-	-	-	1	5
16,	30.22	34	20	69	-	506	156	81	87	6	31	6	1	3	3	-	-	2	-	6
23,	29.94	38	19	66	-	509	158	50	83	10	19	3	6	11	3	-	-	1	1	5
30,	29.51	28	15	65	3.81	572	173	62	94	6	34	3	2	9	1	-	-	2	1	3
Feb. 6,	30.29	35	19	69	-	634	193	78	116	8	37	6	1	10	1	-	-	-	3	4
13,	29.96	36	24	83	-	590	182	60	111	5	17	6	1	2	2	-	-	-	1	9
20,	29.98	40	17	67	-	607	172	66	132	2	24	1	1	8	1	-	-	-	2	10
27,	30.06	39	26	67	2.51	585	165	56	117	6	16	5	5	3	2	-	-	1	1	4
March 6,	30.35	44	23	71	-	647	192	74	138	7	22	4	2	11	3	-	-	-	-	8
13,	30.15	45	29	70	-	700	210	78	160	6	23	4	3	13	4	-	-	-	1	5
20,	30.11	33	25	65	-	598	177	53	121	8	11	7	5	5	-	-	-	-	1	3
27,	29.63	46	35	77	3.03	585	176	54	116	1	26	8	1	8	1	-	-	-	2	10
April 3,	30.24	49	33	44	-	574	154	67	117	8	20	5	2	2	3	-	-	-	4	10
10,	30.37	49	39	85	-	642	209	66	110	5	24	6	3	5	2	-	-	-	-	11
17,	30.08	56	40	69	-	613	180	61	116	5	30	10	-	4	2	-	-	1	2	14
24,	30.28	64	38	53	2.89	581	192	62	103	5	13	8	3	8	5	-	-	1	-	22
May 1,	29.88	60	45	73	-	592	194	63	98	2	21	15	1	5	2	1	-	1	5	25
8,	30.02	57	43	78	-	552	172	60	78	6	18	9	2	6	1	-	1	-	1	23
15,	29.91	70	53	85	-	606	201	69	83	2	29	11	-	6	4	-	-	1	4	20
22,	30.04	69	52	67	-	562	185	61	73	3	17	4	1	8	9	-	-	2	4	28
29,	29.89	66	52	75	4.55	478	169	55	59	3	25	12	3	6	2	-	-	1	2	14
June 5,	29.92	68	51	72	-	488	141	48	62	5	16	6	-	8	1	-	-	2	-	21
12,	30.05	65	51	87	-	488	147	65	48	-	22	7	3	11	2	-	1	-	2	11
19,	29.84	72	55	71	-	510	130	60	58	6	12	8	4	18	3	-	1	-	2	9
26,	29.79	78	57	62	5.03	493	168	54	50	5	12	4	3	22	2	-	-	-	2	10
July 3,	29.94	77	58	70	-	456	159	54	52	3	14	4	1	41	4	-	-	1	-	12
10,	30.04	86	66	81	-	608	172	50	52	9	14	5	4	87	5	-	-	-	3	16
17,	29.93	82	67	79	-	580	278	47	31	4	17	8	1	138	3	-	-	-	2	10
24,	30.04	78	66	84	-	641	349	45	20	3	18	3	1	184	2	-	-	1	1	6
31,	29.95	70	59	81	7.86	649	372	50	20	2	8	2	1	210	1	-	-	-	-	6
Aug. 7,	30.07	79	62	75	-	666	339	45	18	10	7	-	-	203	3	-	-	1	-	8
14,	29.91	79	63	70	-	668	263	46	20	9	8	2	-	211	3	-	-	1	1	8
21,	29.97	77	62	79	-	653	346	49	19	10	11	2	-	196	3	1	-	-	-	6
28,	29.95	75	60	84	4.70	638	289	64	18	17	14	2	1	167	4	-	-	-	-	4

Sept. 4,	30.10	73	59	71	-	605	315	45	35	15	14	2	-	134	4	-	-	-	-	6
11,	30.16	85	62	70	-	570	276	58	34	16	4	8	-	100	3	-	-	-	-	10
18,	30.05	69	53	79	-	586	239	59	25	14	15	3	-	93	1	-	-	-	-	7
25,	30.07	68	51	78	2.14	527	217	48	28	16	15	-	-	69	2	-	-	-	-	7
Oct. 2,	30.19	69	48	61	-	493	199	49	41	8	10	2	-	58	1	1	-	1	-	5
9,	30.15	66	46	66	-	519	183	59	58	15	14	-	-	43	-	-	-	-	-	5
16,	30.19	73	53	71	-	552	196	61	52	11	17	2	-	44	1	-	-	-	-	6
23,	30.19	58	41	69	-	517	193	57	61	12	22	-	-	34	2	-	-	-	-	6
30,	30.01	55	42	82	0.80	489	179	46	51	6	26	3	-	30	-	-	-	1	1	4
Nov. 6,	30.03	59	41	78	-	498	161	70	69	11	20	1	-	13	2	-	-	-	-	5
13,	29.70	51	36	75	-	481	131	60	60	9	15	2	-	11	-	2	-	1	2	6
20,	30.26	44	32	77	-	448	154	63	64	15	13	2	-	10	1	-	-	-	-	5
27,	30.14	50	29	79	6.52	487	155	47	78	11	22	2	-	7	1	-	-	1	2	7
Dec. 4,	30.32	36	25	71	-	491	106	64	72	6	5	1	-	5	-	-	-	1	4	3
11,	29.99	49	36	86	-	491	134	50	91	9	16	4	-	6	1	-	-	1	-	7
18,	29.98	49	37	86	-	433	116	55	65	4	15	2	-	4	1	-	-	-	2	1
25,	29.90	29	16	67	-	473	184	46	73	17	6	3	-	8	2	-	-	1	2	6
Jan. 1,	29.90	36	22	77	4.67	454	113	62	74	11	5	-	-	5	-	-	-	-	-	1
Totals,	-	-	-	-	48.51*	28,987	10,277	3,022	3,732	402	922	231	69	2,307	113	5	3	26	61	463
Weekly averages,	-	-	-	-	-	557	197	58	72	8	18	4.4	1.300	44	2.130	0.100	0.060	0.500	1.170	9
Rate per 1,000 deaths,	-	-	-	-	-	-	354.50	104.20	128.70	13.90	31.80	7.97	2.38	79.60	3.90	0.17	0.10	0.89	2.10	16.00
Rate per 1,000 population,	-	-	-	-	-	18.9	6.70	1.97	2.43	0.26	0.60	0.15	0.045	1.50	0.074	0.003	0.002	0.017	0.039	0.30

Average reporting population, ... 1,533,700

* The figures in this column represent the rainfall by months. The total for the year (48.5 inches) was about 3.5 inches greater than the yearly mean for Massachusetts.

Total Deaths.

The whole number of deaths reported for the year 1897 from the cities and towns contributing to these reports was 28,987, and the average number per week was 557. The whole number was less by 1,815 than the number reported from the same towns in 1896, and only 9 more than the number reported in 1895. The greatest number of deaths reported in a single week was 700, in the week ending March 13; the least number was 433, in the week ending December 18. The weekly average number of deaths reported for each month was as follows: —

January,	546	July,	587
February,	604	August,	631
March,	632	September,	572
April,	602	October,	514
May,	558	November,	478
June,	495	December,	469

The percentages of mortality in each of the four quarters of the year were as follows: —

	All Ages.		Ages under 5 Years.	
	Numbers.	Percentages.	Numbers.	Percentages.
First quarter,	7,132	24.60	2,117	20.60
Second quarter,	7,179	24.77	2,242	21.82
Third quarter,	7,847	27.07	3,714	36.14
Fourth quarter,	6,829	23.56	2,208	21.44
	28,987	100.00	10,277	100.00

Deaths under Five Years of Age.

The reported number of deaths of children under five years of age was 10,277. This was less than the number reported in 1896 by 700, but greater than that of 1895 by 163. The average weekly number was 197. The greatest number reported in one week was 372, in the week ending July 31, and the least number was 106, in the week ending December 4. The ratio of the deaths of this class to the total reported mortality was 35.4 per cent. The average weekly number of deaths of children under five years of age by months was as follows: —

January,	162	July,	286
February,	178	August,	309
March,	189	September,	362
April,	184	October,	190
May,	184	November,	150
June,	146	December,	131

The months having the greatest number of deaths of children under five years of age were July, August and September, and those having the least number were January, June and November.

Consumption.

The number of reported deaths from consumption was 3,022. This number was less than those reported in 1896 by 221, and less than those of 1895 by 97. The weekly average was 58. The greatest number of deaths reported from this cause in a single week was 81, in the week ending January 16, and the least number was 45, in the weeks ending July 24, August 7 and September 4. The average weekly number of reported deaths from this cause in each month was as follows: —

January,	66	July,	61
February,	65	August,	51
March,	65	September,	52
April,	64	October,	54
May,	62	November,	60
June,	57	December,	55

The following table presents the variations from the weekly average number of deaths from this cause for the past five years: —

	1894.	1895.	1896.	1897.		1894.	1895.	1896.	1897.
January,	+10	–4	+1	+8	July,	-	–9	–1	+3
February,	+7	+17	+3	+7	August,	–4	–13	+10	–7
March,	+9	+15	–1	+7	September,	–3	–7	–7	–6
April,	–1	+4	+21	+6	October,	–6	–1	–5	–4
May,	–7	-	+2	+4	November,	–7	–1	–10	+2
June,	–1	+2	+1	–1	December,	+2	–4	–9	–3

The ratio of reported deaths from consumption to the mortality reported from all causes was 104.2, while that of previous years was as follows: —

1888,	134.2	1893,	106.5
1889,	125.0	1894,	111.8
1890,	130.0	1895,	107.7
1891,	116.5	1896,	105.3
1892,	111.3	1897,	104.2

The ratio to the reported living population in 1897 was 1.97 per 1,000, as compared with 2.19 in 1896.

Acute Lung Diseases.

The number of reported deaths from acute lung diseases (bronchitis, pneumonia, pleurisy and asthma) during the year was 3,732, and the weekly average was 72. The greatest number of deaths reported from this group of causes in a single week was 160, in the week ending March 13, and the least number was 18, in the week ending August 7. The average weekly number of reported deaths from these causes for each month was as follows: —

January,	94	July,	35
February,	119	August,	19
March,	134	September,	30
April,	111	October,	53
May,	78	November,	68
June,	54	December,	75

The months having the greatest number of reported deaths from these causes were February and March, and those having the least number were July and August. The ratio of reported deaths from acute lung diseases to the reported mortality from all causes was 128.7 per 1,000. The estimated death-rate per 1,000 of the reporting population from these causes was 2.43, as compared with 2.67 in 1896.

Typhoid Fever.

The total number of reported deaths from this cause in 1897 was 402, and the average weekly number was 8. The greatest number reported in any single week from this cause was 17, in the weeks ending August 28 and December 25, and there were no deaths reported from typhoid fever for the week ending June 12. The average weekly number of deaths reported from this cause for each month was as follows: —

January,	8	July,	4
February,	5	August,	12
March,	5	September,	15
April,	6	October,	10
May,	3	November,	12
June,	4	December,	9

The months having the least number of deaths from this cause were May and June, and those having the greatest number were September and October. The ratio of reported deaths from typhoid fever to the reported mortality from all causes was 14.2 per 1,000, and the ratio to the reporting population was .26 per 1,000, as compared with .30 in the previous year.

Diphtheria and Croup.

The total number of reported deaths from diphtheria and croup in 1897 was 922, and the average number in each week was 18. The greatest number reported in a single week from these combined causes was 38, in the week ending January 9, and the least number was 4, in the week ending September 11. The average number of reported deaths from these causes for each month was as follows: —

January,	30	July,	14
February,	24	August,	10
March,	20	September,	12
April,	22	October,	18
May,	22	November,	17
June,	15	December,	9

The ratio of deaths from diphtheria and croup to the reported mortality from all causes was 31.8 per 1,000, and the death-rate for the reporting population was .60 per 1,000, as compared with .83 in the previous year.

Scarlet-fever.

The reported deaths from scarlet-fever in 1897 were 231. The greatest number reported from this cause in a single week was 15, in the week ending May 1. There were five weeks in which no deaths from scarlet-fever were reported. The average weekly number reported in each month was as follows: —

January,	5	July,	4
February,	4	August,	2
March,	6	September,	3
April,	7	October,	1
May,	10	November,	2
June,	6	December,	2

The ratio of deaths from this cause to the reported deaths from all causes was 7.97 per 1,000, and the death-rate of the reporting population from this cause was .15 per 1,000, as compared with .13 in the previous year.

Diarrhœal Diseases.

The diseases included in this group are diarrhœa, dysentery, cholera morbus and cholera infantum. From these causes combined the number of deaths reported in 1897 was 2,307, and the weekly average number was 44. The greatest number reported in a single week was 211, in the week ending August 14, and the least number

was 2, in the weeks ending February 13 and April 3. The average weekly number of reported deaths from these causes in each month was as follows: —

January,	7	July,	132
February,	6	August,	194
March,	9	September,	99
April,	5	October,	42
May,	6	November,	8
June,	15	December,	5

The months having the greatest number of reported deaths from these causes in 1897 were July, August and September, and those having the least were February, April and December.

The deaths from these causes in the third quarter of the year constituted 79.4 per cent. of the number of deaths from the same causes for the entire year. The ratio of the reported deaths to the reported mortality from all causes was 79.6 per 1,000, and the death-rate of reporting population from these causes was 1.50, as compared with 1.84 in 1896.

Cerebro-spinal Meningitis.

The total number of reported deaths from this cause was 463, and the weekly average was 9. The greatest number reported in any week from this cause was 28, in the week ending May 22, and the least number was 1, in the weeks ending December 18 and January 1. The average weekly number of deaths reported from this cause for each month was as follows: —

January,	5	July,	10
February,	7	August,	6
March,	6	September,	8
April,	14	October,	5
May,	22	November,	6
June,	12	December,	3

The months having the greatest number of reported deaths from this cause were April and May, and those having the least were October and December. The ratio of reported deaths from cerebro-spinal meningitis to the reported mortality from all causes was 15.9 per 1,000, and the ratio to the reporting population was .30 per 1,000, or twice as great as that of the previous year. The deaths from this cause which were reported in the three months of April, May and June constituted nearly 50 per cent. of the whole number reported during the year.

Whooping-cough, Malarial Fever, Erysipelas, Puerperal Fever and Small-pox.

The essential statistics relating to these five diseases are embraced in the following table: —

	Total Deaths Reported.	Weekly Averages.	Ratio per 1,000 of Total Reported Deaths.	Ratio per 1,000 of Reporting Population.
Whooping-cough,	113	2.13	3.90	.074
Erysipelas,	61	1.17	2.10	.039
Puerperal fever,	26	0.50	0.81	.017
Small-pox,	3	0.06	0.10	.002
Malarial fever,	5	0.10	0.17	.003

II.

Fatality (Ratio of Deaths to Cases) from Certain Infectious Diseases in 1897.

The statistics presented in the following table are compiled from the published reports of local boards of health for the year 1897 which have been forwarded to the office of the State Board of Health. They are the figures representing the numbers of cases reported to local boards of health under the provisions of section 79 of chapter 80, Public Statutes.

The numbers of deaths are also obtained from the same reports, and the comparison of these two series of figures presents a fairly accurate method of arriving at the fatality from these diseases in the places from which they are reported. The figures representing the numbers of cases are probably less than the actual numbers, since some cases must necessarily escape registration through neglect to report or in consequence of faulty diagnosis.

Cases of Infectious Diseases and Deaths reported to Local Boards of Health, 1897.

City or Town.	Diphtheria and Croup.		Scarlet-fever.		Typhoid Fever.		Measles.	
	Cases.	Deaths.	Cases.	Deaths.	Cases.	Deaths.	Cases.	Deaths.
Acushnet,	2	2	-	-	3	1	36	1
Adams,	64	8	12	1	4	4	-	-
Amesbury,	40	4	36	1	18	2	3	-
Andover,	8	-	5	-	1	-	68	-
Arlington,	8	-	10	-	-	-	-	-
Athol,	20	3	-	-	-	-	140	-
Attleborough,	32	4	34	-	7	-	9	-
Ayer,	3	-	1	-	4	2	5	-
Barre,	3	1	3	1	-	-	6	-
Belmont,	24	2	12	-	3	-	11	-
Beverly,	24	2	34	-	8	1	164	-
Boston,	3,398	456	1,938	136	609	173	4,539	21
Bridgewater,	2	-	45	-	2	-	-	-

Cases of Infectious Diseases and Deaths reported to Local Boards of Health, 1897 — Continued.

City or Town.	Diphtheria and Croup.		Scarlet-fever.		Typhoid Fever.		Measles.	
	Cases.	Deaths.	Cases.	Deaths.	Cases.	Deaths.	Cases.	Deaths.
Brockton,	127	22	41	4	17	5	326	2
Brookline,	30	5	51	-	4	2	49	-
CAMBRIDGE,*	321	51	231	10	105	11	410	3
CHELSEA,	88	13	162	1	10	6	13	1
CHICOPEE,	55	9	5	-	-	-	-	-
Cohasset,	2	-	1	-	1	1	5	-
Colrain,	-	-	23	-	-	-	-	-
Concord,	13	1	9	1	5	1	45	-
Danvers,	26	3	20	1	9	2	17	-
Dedham,	32	3	3	-	6	-	26	-
Easthampton,	3	-	10	-	-	-	6	-
EVERETT,	150	25	55	5	27	4	304	2
FALL RIVER,	35	10	190	6	154	32	-	-
FITCHBURG,	83	13	10	-	31	5	757	1
Framingham,	16	6	21	-	5	2	28	1
Franklin,	3	-	4	-	-	-	7	-
Foxborough,	8	-	8	-	11	-	4	-
Gardner,	16	7	73	1	17	2	-	-
GLOUCESTER,†	43	4	43	-	20	1	-	-
Great Barrington,	-	-	1	-	-	-	-	-
Greenfield,	18	1	8	2	7	2	45	-
Hardwick,	9	1	2	-	-	-	-	-
HAVERHILL,	96	20	153	5	125	16	45	1
Hingham,	37	-	4	-	-	-	-	-
Holyoke,†	39	2	25	2	16	3	73	6
Hudson,	5	1	62	1	5	1	7	-
Hull,	2	-	-	-	-	-	8	-
Hyde Park,	70	8	47	1	16	2	27	1
Ipswich,	64	6	-	-	6	1	3	-
Lee,	2	-	4	-	4	-	-	-
Leicester,	-	-	1	-	3	-	3	-
Leominster,	40	6	18	-	4	2	136	-
Lexington,	4	-	3	-	3	-	45	-
LOWELL,	176	41	90	2	105	18	1,086	9
LYNN,	254	20	66	2	87	19	352	4

* Small-pox, 2 cases, both fatal. † Small-pox, 1 case.

Cases of Infectious Diseases and Deaths reported to Local Boards of Health, 1897 — Continued.

City or Town.	Diphtheria and Croup.		Scarlet-fever.		Typhoid Fever.		Measles.	
	Cases.	Deaths.	Cases.	Deaths.	Cases.	Deaths.	Cases.	Deaths.
Malden,	124	15	61	1	54	4	850	1
Manchester,	-	-	10	-	-	-	1	-
Marblehead,	13	2	6	-	6	2	-	-
Marlborough,	1	1	45	-	2	1	44	-
Maynard,	26	1	1	-	-	-	-	-
Medford,	41	-	37	-	11	1	93	2
Melrose,	16	2	23	-	4	2	571	3
Middleborough,	5	1	4	-	6	-	-	-
Milford,	11	2	4	1	-	-	2	-
Nantucket,	-	-	1	-	-	-	-	-
Natick,	11	3	34	1	2	1	3	-
Needham,	10	3	9	-	3	2	-	-
New Bedford,*	143	47	141	13	88	23	586	5
Newburyport,	30	7	4	-	8	5	1	-
Newton,	114	12	119	5	50	5	715	-
North Adams,†	54	18	62	1	50	9	2	-
Northampton,	125	21	33	1	12	3	25	-
North Andover,	6	1	13	-	7	1	7	-
North Attleborough,	3	1	6	-	9	2	4	-
Norwood,	9	-	15	-	9	-	3	-
Pittsfield,	112	7	8	1	15	3	2	-
Plymouth,	4	2	60	2	9	-	-	-
Quincy,	24	2	41	2	13	4	439	2
Reading,	4	3	10	-	4	1	6	-
Revere,	23	3	38	-	-	-	-	-
Rockland,	5	-	22	-	-	-	107	-
Salem,	200	19	84	4	19	2	-	-
Saugus,	11	-	20	-	-	-	2	-
Sharon,	1	-	1	-	-	-	2	-
Somerville,‡	324	44	158	6	50	11	-	-
Springfield,	119	26	113	4	41	15	69	6
Stoneham,	2	-	9	-	-	-	-	-
Swampscott,	6	1	12	-	4	-	3	-
Taunton,	50	9	70	4	10	6	17	2
Tewksbury,	2	-	23	-	-	-	123	-

* Whooping-cough, 11; small-pox, 1. † Chicken-pox, 5. ‡ Small-pox, 2 cases, 1 fatal.

Cases of Infectious Diseases and Deaths reported to Local Boards of Health, 1897 — Concluded.

City or Town.	Diphtheria and Croup.		Scarlet-fever.		Typhoid Fever.		Measles.	
	Cases.	Deaths.	Cases.	Deaths.	Cases.	Deaths.	Cases.	Deaths.
Wakefield,	60	7	49	3	11	2	34	-
Walpole,	3	2	2	-	3	-	14	-
WALTHAM,*	87	6	40	2	19	2	-	-
Ware,	14	3	-	-	1	-	-	-
Warren,	10	1	7	-	4	-	59	-
Watertown,	58	5	73	8	14	1	169	2
Wellesley,	7	1	5	-	1	-	7	-
Westfield,	6	2	22	-	14	4	16	-
Westford,	4	-	13	-	1	-	203	-
Weston,	3	-	6	-	1	-	-	-
Whitman,	6	-	8	-	2	-	-	-
WOBURN,	92	5	23	-	14	3	155	3
WORCESTER,	312	55	254	8	100	15	522	17
Winchendon,	17	3	3	-	14	2	6	-
Winchester,	53	4	30	3	4	1	35	-
Totals,	7,856	1,107	5,406	253	2,151	454	13,705	96
Fatality, per cent.,	14.1		4.7		21.1		0.7	

* Small-pox, 2 cases.

The cities and towns embraced in the foregoing table are 98 in number, or 20 more than those presented in the previous year. They comprise about three-fourths of the population of the State.

The reported cases of diphtheria and croup were less than those of 1896, and the number of deaths was less than that of either of the three preceding years and the fatality was also less, being only 14.1.

The reported cases of scarlet-fever were more than those reported in 1896, and the fatality (4.7 per cent.) was less than that of any year since 1892.

The reported cases of typhoid fever were less than those of any year since 1892, and the fatality (21.1) was greater than that recorded in any previous year since 1892.

The reported cases of measles were far more than those of any previous year, but the fatality (0.7) was less.

The figures for 1897 are as follows : —

Reported cases of diphtheria and croup,	7,856
Registered deaths from diphtheria and croup in the same cities and towns,	1,107
Fatality (per cent.),	14.1
Reported cases of scarlet-fever,	5,406
Registered deaths from scarlet-fever in the same cities and towns,	253
Fatality (per cent.),	4.7
Reported cases of typhoid fever,	2,151
Registered deaths from typhoid fever in the same cities and towns,	454
Fatality (per cent.),	21.1
Reported cases of measles,	13,705
Registered deaths from measles in the same cities and towns,	96
Fatality (per cent.),	0.7

The following table presents the summary of these statistics for the seven years 1891–97 : —

Reported Cases of Infectious Diseases in Massachusetts.

Diphtheria and Croup.

[Pre-Antitoxin Period.]

	1891.	1892.	1893.	1894.	Total.
Reported cases,	2,444	3,033	2,919	4,936	13,332
Deaths,	575	891	926	1,376	3,768
Fatality (per cent.),	23.5	29.2	31.7	27.9	28.3

Diphtheria and Croup.

[Antitoxin Period.]

	1895.	1896.	1897.	Total.
Reported cases,	7,856	8,915	7,856	24,627
Deaths,	1,484	1,348	1,107	3,939
Fatality (per cent),	18.9	15.1	14.1	16.0

Scarlet-fever.

	1891.	1892.	1893.	1894.	1895.	1896.	1897.	Total.
Reported cases,	4,517	6,112	7,420	7,416	6,050	3,873	5,406	40,794
Deaths,	151	281	624	504	357	220	253	2,388
Fatality (per cent.),	3.3	4.6	8.8	6.8	5.9	5.7	4.7	5.9

Typhoid Fever.

	1891.	1892.	1893.	1894.	1895.	1896.	1897.	Total.
Reported cases, ...	2,414	1,892	2,457	2,814	2,665	3,016	2,151	17,409
Deaths, ...	460	435	492	488	458	471	454	3,253
Fatality (per cent.), . . .	19.0	23.0	20.0	17.0	17.2	15.6	21.1	18.7

Measles.

	1891.	1892.	1893.	1894.	1895.	1896.	1897.	Total.
Reported cases, ...	5,861	783	6,290	2,051	5,033	6,861	13,705	40,644
Deaths, ...	84	31	98	37	75	65	96	486
Fatality (per cent.), . . .	1.4	4.0	1.6	1.8	1.5	0.9	0.7	1.2

In the foregoing table the statistics relating to diphtheria and croup have been arranged in two periods, which may properly be called the pre-antitoxin and the antitoxin periods, since antitoxin came into general use in the State about the beginning of the year 1895. The mean fatality in the former period (1891–94) was 28.3 per cent. (ratio of deaths to cases), and in the latter period (1895–97) it was 16 per cent.

In order to compare the general fatality from diphtheria in Massachusetts with that of another country in which systematic notification of a large number of cases has been conducted for a period of several successive years, the following figures for England are presented, as published in the annual reports of the Local Government Board: —

England.

[Local Government Board figures.]

	Diphtheria.		Croup.		Total.		Per Cent.
	Cases.	Deaths.	Cases.	Deaths.	Cases.	Deaths.	
1890, ...	–	–	–	–	2,953	753	25.5
1891, ...	–	–	–	–	11,919	2,829	23.7
1892, ...	13,977	3,177	1,169	401	15,146	3,578	23.6
1893, ...	20,712	4,751	1,436	685	22,148	5,436	24.5
1894, ...	17,581	4,236	1,256	486	18,837	4,722	25.1
1895, ...	18,700	4,225	1,263	540	19,963	4,765	23.9
1896, ...	25,498	5,372	1,365	556	26,863	5,928	22.1
Total, ...	96,468	21,761	6,489	2,668	117,829	28,011	–
Mean fatality (per cent.), .	22.6		41.1		23.8		23.8

The following figures present the fatality from diphtheria and croup, scarlet-fever and typhoid fever in England, as reported by the Local Government Board of England for the years 1890–96 : —

	1890.	1891.	1892.	1893.	1894.	1895.	1896.
Diphtheria and croup,	25.5	23.7	23.6	24.5	25.1	23.9	22.1
Scarlet-fever,	8.0	5.8	4.4	4.2	4.8	4.2	4.0
Typhoid fever,	19.9	20.8	17.8	17.0	17.5	16.9	17.7

III.

Official Returns of Notified Diseases Dangerous to the Public Health, 1897.

The following summary embraces the returns of diseases "dangerous to public health," made to the State Board of Health under the provisions of chapter 302 of the Acts of 1893. Since the act in question did not specify the diseases intended to be reported to the Board (except small-pox) the Board issued a circular, in which it expressed its opinion as to the particular diseases which should be reported under the provisions of this act. They were the following: *small-pox, scarlet-fever, measles, typhoid fever, diphtheria, membranous croup, cholera, yellow fever, typhus fever, cerebro-spinal meningitis, hydrophobia, malignant pustule, leprosy and trichinosis.*

The report of 1893 embraced the returns of the fractional year only which immediately followed the enactment of the statute, while those of 1894, 1895 and 1896 were each for a full year.

The whole number of cases of infectious diseases reported in 1897 was 27,925, which were divided as follows: —

Reported cases of small-pox,	18
Reported cases of diphtheria and croup,	7,613
Reported cases of scarlet-fever,	5,495
Reported cases of typhoid fever,	2,104
Reported cases of measles,	12,695
Total,	27,925

The summary for the five years 1893–97 is as follows: —

	Reported Cases of				
	Small-pox.	Diphtheria and Croup.	Scarlet-fever.	Typhoid Fever.	Measles.
1893 (four months only),	35	1,109	2,914	1,525	1,503
1894,	181	4,178	6,731	2,372	2,133
1895,	1	7,806	6,194	2,438	4,868
1896,	5	8,515	3,801	2,637	6,362
1897,	18	7,613	5,495	2,104	12,695
Total,	240	29,221	25,135	11,076	27,561

Seasonal Distribution. — By months these diseases were reported as follows in 1897 : —

Cases of Infectious Diseases reported to the Board by Months during 1897.

	Diphtheria.	Scarlet-fever.	Typhoid Fever.	Measles.		Diphtheria.	Scarlet-fever.	Typhoid Fever.	Measles.
January, ...	1,045	537	178	1,983	August, . . .	323	258	242	108
February, . . .	727	415	83	1,846	September, . .	382	225	311	38
March, ...	600	593	78	2,142	October, . . .	667	339	410	48
April, ...	630	654	86	2,075	November, . .	790	394	226	48
May, ...	674	799	94	2,412	December, . .	692	372	178	136
June, ...	584	550	96	1,357					
July, ...	447	305	98	493	Total, . .	7,561*	5,441*	2,080*	12,686*

* The difference between the figures in this line of totals and that which is given in the preceding table is accounted for by the fact that three towns, Natick, Revere and Wellesley, sent returns in which the number of cases were not specified by months. The cases reported in those towns were as follows : —

	Diphtheria and Croup.	Scarlet-fever.	Typhoid Fever.	Measles.
Natick, ...	38	21	4	-
Revere, ...	7	5	20	7
Wellesley, ...	7	28	-	2
	52	54	24	9

In order that the foregoing figures may be interpreted with greater facility the following table is appended : —

Intensity of Prevalence

	Diphtheria and Croup.			Scarlet-fever.			Typhoid Fever.			Measles.		
	1897.		1896.	1897.		1896.	1897.		1896.	1897.		1896.
	A	B	B	A	B	B	A	B	B	A	B	B
January, . .	33.7	16.8	12.4	17.3	11.6	12.6	5.7	10.1	6.4	64.0	18.5	6.4
February, . .	25.1	12.5	11.3	14.3	9.6	10.5	2.9	5.0	4.4	63.7	18.4	8.7
March, . . .	19.3	9.6	8.9	19.1	12.9	11.4	2.5	4.4	3.2	69.1	19.9	8.4
April, . . .	21.0	10.5	7.3	21.8	14.7	10.7	2.9	5.0	3.1	69.2	20.0	8.9
May, . . .	21.7	10.8	10.2	25.8	17.3	9.7	3.0	5.3	4.9	77.8	22.4	16.8
June, . . .	19.5	9.7	8.9	18.3	12.3	10.7	3.2	5.6	5.3	45.2	13.0	18.0
July, . . .	14.4	7.2	7.1	9.8	6.6	6.4	3.2	5.6	6.0	15.9	4.6	8.9
August, . . .	10.4	5.2	7.2	8.3	5.6	5.9	7.8	13.7	14.4	3.5	1.0	3.3
September, . .	12.7	6.3	7.6	7.5	5.0	6.3	10.4	18.3	18.9	1.3	.4	4.0
October, . .	21.5	10.7	14.4	10.9	7.4	9.9	13.2	23.3	27.2	1.5	.4	6.4
November, . .	26.3	13.1	13.0	13.1	8.8	13.2	7.5	13.3	16.0	1.6	.5	10.2
December, . .	22.3	11.1	11.4	12.0	8.1	12.4	5.7	10.1	10.0	4.4	1.3	19.9
Mean, . .	20.7	10.0	10.0	14.9	10.0	10.0	5.7	10.0	10.0	34.7	10.0	10.0

The figures in the foregoing table are introduced for the purpose, not of comparing the prevalence of one disease with another, but of

presenting the reports of each month upon a uniform basis of comparison, month by month, so that the relative intensity of each disease is shown for each month. The method also has the advantage of eliminating the apparent errors of computation arising from the unequal length of the months.

The figures may be read as follows: for example, the mean daily number of reported cases of diphtheria and croup in January, 1897, was 33.7; of scarlet-fever, 17.3; of typhoid fever, 5.7; and of measles, 64.0 (see columns marked A); and the mean daily number of the same diseases for the whole year 1897 was, respectively, 20.7, 14.9, 5.7 and 34.7. Assuming a standard of 10 as the daily mean of each disease for the year, the ratios for January were as follows: diphtheria and croup, 16.8; scarlet-fever, 11.6; typhoid fever, 10.1; and measles, 18.5 (see columns marked B). That is to say, for each 10 reported cases of diphtheria and croup occurring throughout the year 1897, as a daily mean, there were 16.8 daily in January, 12.5 in February, etc.

The foregoing table shows that the seasonal prevalence of these four infectious diseases has followed very nearly the same course in each of the years 1896 and 1897, and this has also coincided with its average prevalence during the past twenty years.

Diphtheria in 1897 prevailed with its greatest severity in January, falling to less than the mean in March and increasing slightly in April and May (this increase in May being noticeable in both the years 1896 and 1897), then falling to a minimum in July, August and September, and rising again in October, November and December in each year.

Scarlet-fever in 1897 was at its maximum in May, having the highest prevalence in the first half of the year and diminishing considerably in the last half. The same was true of 1896, except that the disease presented a sharp rise in November and December.

Typhoid fever followed very nearly in the same course in each year, its prevalence being moderate in the first six months and then rising sharply till October, but diminishing again to the end of the year.

Measles in each year prevailed with greater intensity in the first half of the year than in the last half. The difference between the prevalence in the first and last six months was much greater in 1897 than it was in 1896. Its sharpest prevalence in 1897 was in May and in 1896 in December. The reported cases of this disease have

greatly increased since 1894, those of 1895 being more than twice as many as those of 1894, those of 1896 thrice as many and those of 1897 six times as many, but the relative fatality was less than that of either of these years. The very sudden decline in the reported cases of measles from May to September in 1897 may undoubtedly be accounted for by the fact that a very large number of immunes had been produced by the unusual prevalence of the preceding months. The history of this disease in Massachusetts for the past forty years has shown that epidemics have occurred about once in every three or four years. There have been ten epidemic years in the past forty years, as follows: in 1858, 1862, 1864, 1872, 1878, 1883, 1887, 1891, 1893 and 1897. More than 80 per cent. of the deaths from measles are those of children under five years old. After each epidemic year a period of comparative freedom from the disease occurs, until a new crop of children comes into existence, who have never had measles, and hence furnish material for a new epidemic. The practice of isolation has not been applied so throughly to this disease as has been done for scarlet-fever, hence the diminution in mortality has not been so apparent.

The following table presents the numbers of cases of each disease reported from each city and town in 1897. The whole number of reporting cities and towns is 172, that of the previous year being 144.

Where the name of a city or town occurs both in Section II. and in Section III. of this summary, the difference in numbers may be taken as the deficiency in returns made by the local board to the State Board of Health.

Cases of Infectious Diseases reported to the State Board of Health from One Hundred and Seventy-two Cities and Towns during 1897.

	Diphtheria.	Scarlet-fever.	Typhoid Fever.	Measles.		Diphtheria.	Scarlet-fever.	Typhoid Fever.	Measles.
Abington, . .	1	–	–	–	Auburn, ...	–	1	–	1
Adams, . . .	64	10	1	–	Avon, ...	1	–	–	1
Agawam, . .	1	–	–	–	Ayer, ...	3	–	2	3
Amesbury, . .	41	38	16	3	Barnstable, . .	3	3	–	5
Amherst, . . .	1	1	3	30	Barre, ...	3	3	–	6
Andover, . . .	3	–	–	–	Bedford, ...	18	1	–	6
Arlington, . .	2	4	–	–	Belchertown, . .	–	–	–	1
Attleborough, . .	29	25	7	5	Berlin, ...	1	2	–	–

Cases of Infectious Diseases reported to the State Board of Health from One Hundred and Seventy-two Cities and Towns during 1897 — Continued.

	Diphtheria.	Scarlet-fever.	Typhoid Fever.	Measles.		Diphtheria.	Scarlet-fever.	Typhoid Fever.	Measles.
BEVERLY,	26	33	7	183	Gill,	–	–	1	49
Bolton,	1	–	2	2	GLOUCESTER,	43	43	21	–
BOSTON,	3,507	2,028	641	4,276	Grafton,	2	1	3	–
Bourne,	–	1	–	–	Granville,	–	–	1	–
Boxford,	–	–	–	1	Great Barrington,	–	1	–	–
Braintree,	2	3	–	–	Groveland,	2	13	5	5
Bridgewater,	3	37	3	–	Hadley,	1	4	1	12
BROCKTON,	106	28	9	239	Hampden,	8	1	–	–
Brookfield,	–	–	3	–	Hardwick,	12	2	–	–
Brookline,	27	53	5	53	Harvard,	1	4	1	–
Burlington,	–	2	–	–	Hatfield,	–	–	1	–
CAMBRIDGE,	322	236	114	400	HAVERHILL,	98	150	122	45
CHELSEA,	74	126	7	15	Hingham,	18	3	–	4
Chelmsford,	7	7	–	109	Hinsdale,	2	10	–	–
Clinton,	5	19	6	119	Holliston,	2	–	–	–
Colrain,	1	18	–	–	Hopkinton,	1	–	–	5
Concord,	13	11	3	45	Hudson,	5	65	4	8
Cottage City,	2	–	1	1	Hull,	–	1	–	7
Danvers,	26	19	9	15	Huntington,	3	–	–	–
Dartmouth,	–	5	–	–	Hyde Park,	21	15	6	8
Dedham,	31	5	7	24	Ipswich,	63	–	6	3
Dighton,	8	7	–	–	Kingston,	–	14	–	2
Douglas,	10	1	1	–	LAWRENCE,	138	263	66	203
Dover,	1	–	–	–	Leicester,	–	1	2	3
Dudley,	2	6	2	–	Leominster,	41	16	6	129
Duxbury,	2	7	7	18	Lexington,	3	2	4	38
East Bridgewater,	2	4	–	–	Lincoln,	1	1	–	–
Easthampton,	–	5	–	–	LOWELL,	186	87	105	1,088
East Longmeadow,	3	1	–	–	LYNN,	183	41	79	187
EVERETT,	135	58	27	279	MALDEN,	119	60	43	756
Fairhaven,	1	2	6	–	Manchester,	–	6	–	–
Falmouth,	2	–	4	21	Mansfield,	1	–	–	–
FALL RIVER,	42	134	100	123	Marblehead,	–	–	–	32
FITCHBURG,	79	10	33	730	MARLBOROUGH,	9	49	6	27
Foxborough,	3	8	10	2	Marshfield,	1	5	–	38
Franklin,	4	7	–	–	Medfield,	–	7	–	20

Cases of Infectious Diseases reported to the State Board of Health from One Hundred and Seventy-two Cities and Towns during 1897 — Continued.

	Diphtheria.	Scarlet-fever.	Typhoid Fever.	Measles.		Diphtheria.	Scarlet-fever.	Typhoid Fever.	Measles.
MEDFORD,	24	10	2	27	Royalston,	-	1	-	-
Medway,	2	-	-	-	SALEM,	166	80	18	-
Merrimac,	2	30	-	-	Sandisfield,	-	5	4	-
Middleborough,	2	-	4	10	Saugus,	11	16	1	2
Middleton,	3	8	-	1	Scituate,	1	4	3	2
Milford,	7	4	-	4	Seekonk,	1	3	-	-
Millbury,	3	2	3	11	Sharon,	2	-	-	-
Milton,	22	25	2	85	Sherborn,	2	-	3	6
Monson,	1	5	3	12	Shirley,	4	3	1	2
Natick,	7	28	-	2	Somerset,	8	5	1	-
Needham,	11	8	4	1	SOMERVILLE,	303	156	50	60
NEW BEDFORD,	142	142	72	579	Southampton,	1	-	1	-
NEWBURYPORT,	14	1	4	1	Southborough,	2	1	-	1
NEWTON,	127	125	52	709	SPRINGFIELD,	139	116	35	81
NORTH ADAMS,	32	24	21	2	Sterling,	1	-	4	-
NORTHAMPTON,	67	11	1	4	Stoughton,	8	3	-	2
North Andover,	6	10	3	9	Stow,	1	-	-	-
Northborough,	3	3	-	-	Sturbridge,	18	-	-	-
Northbridge,	1	1	2	-	Sutton,	1	3	7	-
North Brookfield,	2	16	2	11	Swampscott,	1	14	5	17
Norton,	18	-	-	-	Swanzey,	1	8	-	-
Norwood,	6	15	8	1	TAUNTON,	48	68	11	17
Orange,	-	1	-	9	Templeton,	-	15	1	3
Palmer,	5	3	1	2	Townsend,	-	1	-	15
Paxton,	-	5	-	-	Truro,	-	-	-	1
Peabody,	88	20	8	-	Upton,	5	23	4	76
Pepperell,	5	7	-	7	Uxbridge,	4	-	1	9
Petersham,	-	1	7	-	WALTHAM,	89	40	12	41
Plymouth,	4	47	5	12	Ware,	13	2	-	-
QUINCY,	23	48	16	411	Wareham,	-	1	1	4
Randolph,	3	4	-	-	Warren,	10	9	4	52
Reading,	5	9	4	2	Watertown,	52	49	8	108
Revere,	38	21	4	-	Webster,	-	24	2	1
Rochester,	1	-	-	-	Wellesley,	7	5	20	7
Rockport,	7	5	4	-	Westborough,	3	-	-	-
Rowley,	8	2	7	1	West Brookfield,	-	3	-	-

Cases of Infectious Diseases reported to the State Board of Health from One Hundred and Seventy-two Cities and Towns during 1897 — Concluded.

	Diphtheria.	Scarlet-fever.	Typhoid Fever.	Measles.		Diphtheria.	Scarlet-fever.	Typhoid Fever.	Measles.
Westfield,	6	13	14	11	Winchendon,	10	2	1	6
Westford,	2	14	2	197	Winthrop,	13	4	2	40
Weston,	3	6	1	–	WOBURN,	78	19	7	80
Westwood,	1	1	–	–	WORCESTER,	296	223	90	443
Weymouth,	21	56	9	47	Wrentham,	1	1	2	–
Whitman,	4	7	3	65	Totals,	7,613	5,495	2,104	12,695
Williamstown,	5	16	18	1					

List of Towns from which no Reports were received.

I. Cities.

CHICOPEE, HOLYOKE.

II. Towns having a Population of More than 5,000 in Each.

Athol,
Blandford,
Framingham,
Gardner,
Greenfield,
Melrose,
Methuen,
Montague,
North Attleborough,
Rockland,
Southbridge,
Spencer,
Stoneham,
Wakefield,
West Springfield,
Winchester. — 16.

III. Towns having a Population of More than 1,000, but less than 5,000 in Each.

Acton,
Acushnet,
Ashburnham,
Ashfield,
Ashland,
Bellingham,
Belmont,
Billerica,
Bradford,
Buckland,
Canton,
Carver,
Charlemont,
Charlton,
Chatham,
Cheshire,
Chester,
Clarksburg,
Cohasset,
Conway,
Dalton,
Deerfield,
Dennis,
Dracut,
Easton,
Edgartown,
Essex,
Freetown,
Georgetown,
Groton,
Hamilton,
Hanover,
Hanson,
Hardwick,
Holbrook,
Holden,
Hopedale,
Hubbardston,
Lancaster,
Lee,
Lenox,
Littleton,
Ludlow,
Lunenburg,
Mattapoisett,
Maynard,
Millis,
Nantucket,
Newbury,
New Marlborough,
Northfield,
Norwell,
Orleans,
Oxford,
Pembroke,
Provincetown,
Raynham,
Rehoboth,
Salisbury,
Sandwich,

LIST OF TOWNS FROM WHICH NO REPORTS WERE RECEIVED — *Concluded.*

III. Towns having a Population of More than 1,000, but less than 5,000 in Each — Concluded.

Sheffield,
Shelburne,
Shrewsbury,
South Hadley,
Stockbridge,
Sudbury,
Tewksbury,
Tisbury,
Topsfield,
Walpole,
Wayland,
West Bridgewater,
West Boylston,
Westminster,
West Newbury,
Westport,
West Stockbridge,
Wilbraham,
Williamsburg,
Wilmington,
Yarmouth. — 81.

IV. Towns having Less than 1,000 Inhabitants.

Alford,
Ashby,
Becket,
Berkley,
Bernardston,
Boxborough,
Boylston,
Brewster,
Brimfield,
Carlisle,
Chesterfield,
Chilmark,
Cummington,
Dana,
Dunstable,
Eastham,
Egremont,
Enfield,
Erving,
Florida,
Gay Head,
Goshen,
Gosnold,
Granby,
Greenwich,
Halifax,
Hancock,
Hawley,
Heath,
Holland,
Lakeville,
Lanesborough,
Leverett,
Leyden,
Longmeadow,
Lynnfield,
Marion,
Mashpee,
Mendon,
Middlefield,
Monroe,
Monterey,
Montgomery,
Mount Washington,
Nahant,
New Ashford,
New Braintree,
New Salem,
Norfolk,
North Reading,
Oakham,
Otis,
Pelham,
Peru,
Phillipston,
Plainfield,
Plympton,
Prescott,
Princeton,
Richmond,
Rowe,
Russell,
Rutland,
Savoy,
Shutesbury,
Southwick,
Sunderland,
Tolland,
Tyngsborough,
Tyringham,
Wales,
Warwick,
Washington,
Wellfleet,
Wendell,
Wenham,
Westhampton,
West Tisbury,
Whately,
Windsor,
Worthington. — 81.

IV.

Official Returns of Deaths in Cities and Large Towns (Chapter 218, Acts of 1894).

The following summary comprises the results obtained from the tabulation of the returns required by chapter 218 of the Acts of 1894, whereby the board of health of each city and populous town is directed to send to the State Board of Health an annual statement of the deaths in such city or town upon a blank form furnished by the State Board.

The whole number of cities and towns included in this list is 85.* The total population of these 85 cities and towns by the census of 1895 was 2,034,658.

The death rates of these towns in the following summary for the year 1897 are calculated upon an estimated population, such estimate being based upon the rate of growth from 1890 to 1895, as taken from the census returns.

This estimate would add one more town to the list for 1897 (Williamstown), and the returns of this town are included in the summary, although not required by the statute, making the total number of towns included in the summary 86.

The estimated population of these 86 towns in 1897 was 2,149,901, or about 80 per cent. of the total population of the State.

The whole number of deaths registered in these towns in 1897 was 38,919, and the death rate calculated upon the foregoing estimated population was 18.1 per 1,000 living. This rate was considerably less than that of 1896.

Sexes. — The number of deaths of males was 19,622, or 50.5 per cent. of the whole number of deaths of those whose sex was known; and the deaths of females were 19,270, or 49.5 per cent. There were 27 in which the sex was not stated in the returns.

Ages. — The deaths shown by four groups of ages, as recommended by Körösi, were as follows: —

* The town of Montague has failed to make the necessary returns in each year since the law was enacted. Hence it has become necessary to complete the returns for that town, as far as possible, from other sources.

Ages.	Deaths. 1897.	Percentages of All Deaths. 1897.	Percentages of All Deaths. 1896.	Ages.	Deaths. 1897.	Percentages of All Deaths. 1897.	Percentages of All Deaths. 1896.
Under 1 year,	9,108	23.47	24.97	20 to 50,	9,684	24.96	24.97
1 to 20,	6,996	18.03	17.75	50 and over,	13,016	33.54	32.31

The deaths of infants under one were 9,108, or 23.47 per cent. of the total mortality, and those of children under five years were 13,281, or 34.23 per cent. of the total mortality.

All of the percentages in this table are estimated upon the number of deaths of persons whose ages were specified in the returns. The total number of deaths in which the age was not specified was 115.

Months and Quarters. — The number of deaths in each quarter of the year is shown in the following table: —

	Deaths. 1897.	Percentages. 1897.	Percentages. 1896.
First quarter,	10,298	26.46	23.58
Second quarter,	9,201	23.64	23.97
Third quarter,	10,662	27.40	30.60
Fourth quarter,	8,758	22.50	21.85
Total,	38,919	100.00	100.00

The intensity of the seasonal death rate is shown in the following table, the method employed being explained on page 633 in Section III., relating to disease notification: —

Seasonal Intensity of the Death Rate.

	Mean Daily Deaths per Month. 1897.	Centesimal Ratio. 1897.	Centesimal Ratio. 1896.		Mean Daily Deaths per Month. 1897.	Centesimal Ratio. 1897.	Centesimal Ratio. 1896.
January,	107.2	100.5	90.84	August,	122.7	115.1	130.38
February,	114.2	107.1	96.08	September,	108.5	101.8	100.79
March,	121.6	114.1	97.56	October,	100.0	93.8	88.03
April,	111.2	104.3	103.51	November,	93.1	87.3	82.18
May,	101.2	94.9	96.22	December,	92.4	86.7	90.41
June,	91.0	85.3	89.40	Annual mean,	106.6	100.0	100.00
July,	116.2	109.0	133.24				

The figures in the foregoing table indicate a greater uniformity in the death rate throughout the year, comparing one month with another, than is shown by the figures of 1896, and reference to the reports of the two preceding years also shows a more uniform death rate than those of 1894 and 1895, which would indicate, when taken in connection with an examination of the table of causes of death, a more healthful year.

In the two years having the highest death rates in Massachusetts in the past half century (1849 and 1872) the maximum departures from the yearly means were, respectively, 83.4 per cent. in August, 1849, and 40 per cent. in August, 1872, while the greatest in 1897 was only 15.1 per cent., in August.

Causes of Death.

Table IV. presents the mortality of the cities and towns embraced in this summary, classified by causes of death for the year 1897. The same figures are again presented in a condensed form in Table V., wherein the comparative mortality from different diseases and groups of diseases for the four years during which the law has been in operation may be examined.

From this table it appears that there has been a decided decrease in the death rate from nearly all of the causes of death enumerated in the table, the principal improvement being shown in the infectious diseases near the top of the column. It is a source of much satisfaction to note that marked changes have taken place in the death rate from those diseases which are clearly preventable, and which may be taken as an index of better sanitary organization and work in the cities and towns named in the list. Consumption, diphtheria, typhoid fever, puerperal fever, and, in a measure, cholera infantum, are diseases which yield to the action of human agencies; and in every one of these there was a marked drop in the death rate, not only as compared with that of 1896, but also with that of the three preceding years embraced within the operations of the statute of 1893.

There are, however, indications that these death rates are based upon an estimate of population which is too high, although estimated upon careful and exact methods. Comment has often been made in these reports upon the fact that estimates made in intercensal years are liable to error in either direction, and that no method, either arithmetical, geometrical or otherwise, can produce exact results in the absence of other definite knowledge. It was for this reason that

the tables of death rates made up from the total estimated population have been published in parallel columns, together with the percentages of the total mortality in each of the annual reports since and including 1892 (see pages xlviii, xlix, twenty-fourth annual report, 1892), and especially in the very full report of last year, embracing the statistics of forty years (1856–95).

The table of percentages of total mortality acts, in a measure, as a check or control in case of erroneous estimates of population. It is for this reason that a similar condensed statement is here introduced in Table V.

The changes in the death rate from consumption, typhoid fever and puerperal fever (see child-birth in report of 1896, page 804) have been quite fully treated in the last annual report. To these may be added the later comments on the changes in the death rate from diphtheria, which appear in the figures of the past three years. The fact that an apparent decrease is shown in such causes of death as suicide and accident, which clearly is not due to active sanitary measures, lends support to the theory of a high estimate of population. A careful examination of the figures in Table V. would seem to indicate a lower annual rate of increase from 1895 to 1897 than the 2.2 per cent. which prevailed from 1890 to 1895.

The following preventable causes of death, consumption, measles, scarlet-fever, diphtheria, whooping-cough, typhoid fever, puerperal fever and cholera infantum, together constituted 27.2 per cent. of the total mortality in 1894, but had fallen off successively to 24.2, 24.2 and 21.9 in the three succeeding years, while the principal acute lung diseases, diseases of the heart, brain, kidneys, cancer, suicide and accident had increased from 35.7 per cent. of the total mortality to 36.9, 36.9 and 38.5 per cent. in the three successive years.

These all combined constituted the greater part of the total mortality in each of the four years 1894–97, and of the diseases specified in the table entitled the "Balance of Mortality," in the last annual report, page 812.

The only cause of death which showed a very marked increase in its death rate over that of previous years was cerebro-spinal meningitis, which prevailed as an epidemic through the spring and early summer of 1897, and gave rise to the special investigation ordered by the Board, the results of which have been published in a separate document.

TABLE I.

Reporting Cities and Towns.	Estimated Population, 1897.	Reporting Cities and Towns.	Estimated Population, 1897.
Adams,	7,286	Millbury,	5,539
Amesbury,	10,060	Milton,	6,014
Andover,	6,146	Montague,*	5,692
Arlington,	6,869	Natick,	8,692
Athol,	7,782	NEW BEDFORD,	62,416
Attleborough,	8,572	NEWBURYPORT,	14,794
BEVERLY,	12,200	NEWTON,	28,990
Blackstone,	5,999	NORTH ADAMS,	20,359
BOSTON,	517,732	NORTHAMPTON,	17,448
Braintree,	5,495	North Attleborough,	6,515
BROCKTON,	35,893	Northbridge,	5,558
Brookline,	17,788	Orange,	5,677
CAMBRIDGE,	86,812	Palmer,	6,992
CHELSEA,	32,716	Peabody,	10,646
CHICOPEE,	17,368	PITTSFIELD,	21,891
Clinton,	11,925	Plymouth,	8,213
Concord,	5,473	QUINCY,	22,562
Danvers,	8,471	Revere,	8,125
Dedham,	7,245	Rockland,	5,647
EVERETT,	22,846	Rockport,	5,769
FALL RIVER,	95,919	SALEM,	36,062
FITCHBURG,	28,392	SOMERVILLE,	57,977
Framingham,	9,620	Southbridge,	8,488
Franklin,	5,258	Spencer,	7,160
Gardner,	9,484	SPRINGFIELD,	54,790
GLOUCESTER,	29,775	Stoneham,	6,335
Grafton,	5,140	Stoughton,	5,440
Greenfield,	6,619	TAUNTON,	27,812
HAVERHILL,	31,406	Wakefield,	8,832
HOLYOKE,	42,364	WALTHAM,	21,812
Hudson,	5,562	Ware,	7,779
Hyde Park,	12,478	Watertown,	8,074
LAWRENCE,	55,510	Webster,	8,105
Leominster,	9,987	Westborough,	5,251
LOWELL,	87,193	Westfield,	11,005
LYNN,	65,220	West Springfield,	6,543
MALDEN,	32,894	Weymouth,	11,461
Marblehead,	7,458	Whitman,	6,264
MARLBOROUGH,	15,445	Williamstown,	5,153
MEDFORD,	15,832	Winchester,	6,665
Melrose,	13,343	WOBURN,	14,449
Methuen,	6,040	WORCESTER,	105,050
Middleborough,	6,938		
Milford,	9,030	Total,	2,149,901

* Montague, no returns; data compiled from town report.

TABLE II.

Total Deaths, Deaths by Sexes and Age Periods, and Still-births in Cities and Towns having over 5,000 Inhabitants in Each, with General Death Rates estimated for 1897.

	Total Deaths.	Males.	Females.	Sex Unknown.	Still-births.	Deaths under 1.	1-2.	2-3.	3-4.	4-5.	5-10.	10-15.	15-20.	20-30.	30-40.	40-50.	50-60.	60-70.	70-80.	Over 80.	Age Unknown.	Rate per 1,000.
Adams,	179	87	92	-	14	43	9	10	3	3	5	4	8	12	15	19	13	11	12	12	-	24.57
Amesbury,	139	65	74	-	14	36	1	4	1	3	3	3	2	8	12	5	18	12	16	15	-	13.82
Andover,	88	38	50	-	3	7	6	2	-	-	3	3	-	4	6	7	8	16	15	11	-	14.32
Arlington,	141	76	65	-	6	35	5	-	-	-	1	1	2	14	15	16	5	16	17	14	-	20.53
Athol,	109	55	50	4	6	12	3	1	3	3	2	3	3	3	6	10	12	12	22	14	-	14.01
Attleborough,	136	62	74	-	7	24	2	3	1	1	3	4	3	12	11	10	13	19	18	11	1	15.87
BEVERLY,	169	81	88	-	6	19	6	4	-	2	6	4	3	17	17	12	16	23	20	20	-	13.85
Blackstone,	127	64	63	-	5	21	7	-	1	1	5	1	1	11	13	9	15	12	19	11	-	21.17
BOSTON,	11,154	5,653	5,501	-	614	2,462	614	308	207	117	345	145	315	1,079	1,187	1,054	1,084	1,032	752	453	-	21.54
Braintree,	110	65	44	1	-	21	4	3	-	3	4	1	2	4	7	7	7	12	19	14	2	20.02
BROCKTON,	473	245	228	-	31	125	22	6	14	10	23	8	11	44	47	26	30	48	35	24	-	13.18
Brookline,	203	98	105	-	17	32	3	3	2	2	8	5	1	13	21	16	21	31	28	17	-	11.41
CAMBRIDGE,	1,531	769	762	-	98	391	97	44	37	22	51	26	44	132	120	94	125	138	124	86	-	17.64
CHELSEA,	650	346	303	1	48	142	20	12	9	2	11	10	18	68	53	58	65	92	65	25	-	19.87
CHICOPEE,	361	200	161	-	19	139	33	15	3	5	11	7	6	28	23	14	25	23	16	13	-	20.79
Clinton,	161	76	85	-	16	54	3	2	1	2	4	1	5	18	11	13	9	15	15	8	-	13.50
Concord,	49	25	24	-	2	3	2	2	-	-	1	1	2	4	3	4	7	5	7	7	1	8.95
Danvers,	112	50	62	-	8	8	2	2	3	-	2	4	3	5	10	12	11	21	17	11	1	13.22
Dedham,	122	63	59	-	7	14	5	1	1	2	2	1	2	12	7	13	14	21	17	10	-	16.84

EVERETT, ...	363	183	180	-	23	88	27	15	10	3	21	7	9	37	19	24	32	39	15	17	-	15.89
FALL RIVER, ...	2,135	1,104	1,031	-	193	802	*-	*-	*-	*-	76	†-	†-	158	141	139	126	146	98	43	-	22.26
FITCHBURG, ...	414	206	208	-	44	98	24	9	9	6	6	7	9	38	29	20	30	54	43	32	-	14.58
Framingham, ...	151	92	55	4	7	23	8	-	2	3	7	1	3	6	9	11	16	19	24	15	4	15.70
Franklin, ...	66	38	25	3	7	9	1	-	-	1	-	-	2	3	5	5	4	18	9	9	-	12.55
Gardner, ...	142	77	64	1	9	33	6	3	2	3	1	4	2	9	5	5	14	17	23	15	-	14.97
GLOUCESTER, ...	311	150	161	-	36	60	‡-	‡-	‡-	‡-	15	§-	§-	26	21	24	21	36	35	17	-	10.45
Grafton, ...	84	49	35	-	3	16	7	1	-	3	1	-	1	4	2	4	5	13	14	13	-	16.34
Greenfield, ...	115	50	65	-	6	15	3	1	1	3	4	3	1	16	4	7	9	14	18	16	-	17.37
HAVERHILL, ...	517	254	263	-	48	101	16	14	8	10	14	6	18	48	56	44	48	55	51	28	-	16.46
HOLYOKE, ...	827	430	397	-	55	197	58	35	19	22	27	10	22	88	57	68	61	42	29	17	75	19.52
Hudson, ...	75	46	28	1	8	9	4	1	1	-	4	2	3	7	4	6	9	12	8	4	1	13.48
Hyde Park, ...	204	98	106	-	14	40	11	6	3	2	5	3	5	22	17	15	23	15	24	13	-	16.35
LAWRENCE, ...	1,087	543	544	-	64	347	49	22	20	21	38	12	27	79	75	77	114	106	66	30	4	19.58
Leominster, ...	144	61	83	-	8	27	3	3	4	4	7	2	5	11	6	10	14	15	14	19	-	14.42
LOWELL, ...	1,855	917	938	-	149	532	124	69	41	20	52	25	43	146	141	134	150	185	118	75	-	21.27
LYNN, ...	988	462	526	-	89	189	46	13	14	14	19	17	26	102	96	69	116	118	81	68	-	15.15
MALDEN, ...	463	202	261	-	25	102	27	12	3	6	14	11	14	37	47	35	35	50	45	25	-	14.08
Marblehead, ...	141	68	73	-	4	10	7	5	6	2	4	2	3	14	10	11	16	15	22	14	-	18.91
MARLBOROUGH, ...	213	107	106	-	12	54	11	5	4	1	6	1	3	24	18	15	21	20	24	6	-	13.79
MEDFORD, ...	216	108	108	-	14	49	10	3	-	2	4	5	8	14	16	15	19	20	29	21	1	13.64
Melrose, ...	180	98	82	-	12	44	9	6	1	-	3	3	4	7	17	10	17	16	27	16	-	13.49
Methuen, ...	93	47	46	-	10	21	3	1	1	1	1	2	1	10	4	6	9	15	10	8	-	15.40
Middleborough, . . .	88	48	40	-	3	6	1	1	-	-	1	1	1	5	5	11	7	10	20	18	1	12.68

* Two hundred and ninety-three between the ages of one and five years.
‡ Thirty-six between the ages of one and five years.
† One hundred and thirteen between the ages of ten and twenty years.
§ Twenty between the ages of ten and twenty years.

TABLE II. — *Concluded.*

	Total Deaths.	Males.	Females.	Sex Unknown.	Still-births.	Deaths under 1.	1-2.	2-3.	3-4.	4-5.	5-10.	10-15.	15-20.	20-30.	30-40.	40-50.	50-60.	60-70.	70-80.	Over 80.	Age Unknown.	Rate per 1,000.
Milford, ...	174	88	86	-	4	22	4	-	2	2	3	1	7	12	13	12	24	31	26	15	-	19.27
Millbury, ...	70	35	35	-	3	16	1	-	1	2	2	1	1	3	4	3	7	12	11	6	-	12.64
Milton, ...	84	51	33	-	9	13	1	3	-	1	3	1	2	7	12	8	7	4	10	11	1	13.97
Montague, ...	98	56	41	1	8	28	6	2	-	2	4	3	-	9	10	7	4	9	4	10	-	17.22
Natick, ...	138	75	63	-	7	22	2	2	1	2	2	3	4	9	9	17	17	16	23	8	1	15.88
NEW BEDFORD, . . .	1,275	631	644	-	100	420	92	42	26	20	38	19	23	88	74	74	92	91	103	73	-	20.43
NEWBURYPORT, . . .	232	108	124	-	17	38	4	4	2	2	4	3	8	18	19	18	18	29	41	24	-	15.68
NEWTON, ...	447	223	224	-	27	102	13	4	6	4	14	8	13	31	39	35	50	53	46	29	-	15.42
NORTH ADAMS, . . .	333	165	168	-	29	96	18	8	5	8	8	7	11	26	19	19	35	34	24	15	-	16.36
NORTHAMPTON, . . .	322	162	160	-	9	56	*-	*-	*-	*-	8	†-	†-	26	18	29	29	37	44	27	-	18.45
North Attleborough, . .	78	38	39	1	3	8	2	-	1	-	1	3	3	9	11	5	7	10	10	8	-	11.97
Northbridge, ...	126	81	45	-	-	49	8	3	2	-	3	3	3	13	1	11	8	7	5	10	-	22.67
Orange, ...	75	31	44	-	10	12	1	-	-	1	2	1	1	5	6	3	14	14	9	6	-	13.21
Palmer, ...	116	65	46	5	9	32	9	1	-	1	4	2	1	10	5	5	10	10	14	10	2	16.60
Peabody, ...	207	106	101	-	12	27	14	6	3	3	13	5	10	12	21	21	16	29	16	11	-	19.44
PITTSFIELD, ...	299	158	141	-	21	54	9	4	7	2	3	4	8	27	27	24	24	33	46	25	2	13.66
Plymouth, ...	152	82	67	3	1	28	5	3	1	1	6	4	5	13	6	9	20	12	28	11	-	18.51
QUINCY, ...	354	181	173	-	14	94	15	5	8	3	6	7	7	27	25	27	36	30	42	22	-	15.69
Revere, ...	149	71	78	-	3	30	8	5	1	1	3	5	8	13	13	10	15	15	13	6	3	18.34
Rockland, ...	84	43	40	1	-	6	4	-	1	2	1	-	2	8	7	3	9	21	10	10	-	14.88

Rockport,	77	44	33	-	3	18	6	3	2	-	3	2	1	1	7	3	8	5	6	10	2	13.35
SALEM,	594	279	315	-	31	135	29	14	10	11	16	7	14	35	41	47	57	66	62	50	-	16.47
SOMERVILLE,	859	426	433	-	57	196	62	23	20	17	37	11	25	59	66	49	59	96	94	44	1	14.82
Southbridge,	159	78	81	-	5	45	6	4	1	2	4	2	8	9	12	8	10	15	14	11	8	18.73
Spencer,	114	58	56	-	7	20	6	4	4	2	3	1	4	11	6	8	5	12	12	16	-	15.92
SPRINGFIELD,	951	467	484	-	55	211	31	13	18	11	30	9	20	91	87	60	77	120	100	72	1	17.36
Stoneham,	96	43	53	-	5	10	1	1	2	-	1	3	3	11	7	7	11	13	17	9	-	15.15
Stoughton,	89	42	47	-	3	17	5	2	-	1	3	-	2	4	7	6	8	6	16	12	-	16.36
TAUNTON,	588	312	276	-	21	113	27	8	8	4	14	3	15	43	39	45	65	82	71	50	1	21.14
Wakefield,	146	62	84	-	9	30	9	3	1	-	7	1	4	16	7	10	9	17	19	13	-	16.53
WALTHAM,	288	141	147	-	11	55	6	3	1	2	12	4	12	25	28	22	26	42	33	17	-	13.20
Ware,	132	66	66	-	11	43	8	5	1	1	3	3	1	11	7	9	11	11	12	6	-	16.97
Watertown,	114	59	55	-	4	23	7	5	-	-	12	-	2	8	9	11	6	14	13	4	-	14.12
Webster,	153	78	75	-	12	38	10	3	2	4	7	3	1	11	13	12	11	12	13	13	-	18.88
Westborough,‡	138	80	58	-	4	13	-	3	1	-	3	1	1	7	16	15	18	20	25	15	-	26.28
Westfield,	154	74	80	-	19	20	2	1	1	-	2	9	2	11	11	15	19	22	22	17	-	13.99
West Springfield,	116	69	47	-	4	23	5	4	3	1	4	6	-	11	9	7	10	12	11	9	1	17.73
Weymouth,	195	100	95	-	8	21	6	2	1	3	8	4	7	8	16	18	17	24	33	26	1	17.01
Whitman,	71	32	38	1	7	13	6	2	-	1	3	2	4	7	4	4	6	4	10	5	-	11.33
Williamstown,	68	34	34	-	7	12	2	-	-	1	2	1	1	9	2	6	3	12	11	6	-	13.20
Winchester,	76	46	30	-	6	10	5	4	1	-	5	-	3	5	8	6	3	8	11	7	-	11.40
WOBURN,	251	122	129	-	18	64	16	6	4	5	9	5	6	19	15	23	18	20	24	17	-	17.37
WORCESTER,	1,791	904	887	-	127	365	86	34	39	16	52	27	56	164	152	152	156	209	181	102	-	17.05
Totals,	38,919	19,622	19,270	27	2,484	9,108	1,856	886	622	444	1,188	540	950	3,341	3,296	3,047	3,469	3,948	3,416	2,183	115	18.10

* Thirty-six between the ages of one and five years.

† Twelve between the ages of ten and twenty years.

‡ Including fifty-two deaths at Westborough Insane Hospital.

TABLE III.

Deaths by Months in Each City and Town having a Population of more than 5,000 by Census of 1895.

	January.	February.	March.	April.	May.	June.	July.	August.	September.	October.	November.	December.
Adams,	18	14	17	20	8	9	13	26	18	9	16	11
Amesbury,	7	9	18	11	17	7	11	11	16	10	11	11
Andover,	9	8	8	9	4	10	6	9	8	5	8	4
Arlington,	10	14	20	12	10	10	8	13	10	13	7	14
Athol,	8	8	13	10	9	8	6	6	10	16	11	4
Attleborough,	12	18	9	10	11	8	19	6	12	14	10	7
BEVERLY,	16	17	17	16	19	7	8	19	13	12	13	12
Blackstone,	15	15	11	8	10	8	9	14	9	7	5	16
BOSTON,	994	946	1,082	1,073	964	765	948	1,000	885	871	813	813
Braintree,	13	7	8	10	12	10	10	9	10	6	6	9
BROCKTON,	51	50	51	40	37	43	38	39	51	33	16	24
Brookline,	17	15	21	13	20	12	16	12	17	21	17	22
CAMBRIDGE,	126	116	121	145	105	115	162	167	130	119	112	113
CHELSEA,	57	59	60	55	57	40	61	52	58	47	41	63
CHICOPEE,	38	27	26	23	24	27	42	46	30	26	31	21
Clinton,	13	11	14	14	17	10	14	8	18	17	6	19
Concord,	4	3	3	7	4	4	5	7	1	5	3	3
Danvers,	9	7	13	15	9	7	10	10	6	10	9	7
Dedham,	12	15	15	10	13	9	6	8	8	9	9	8

EVERETT,	25	24	38	33	24	23	21	37	30	32	37	39
FALL RIVER,	177	164	191	165	149	155	299	228	187	164	136	120
FITCHBURG,	48	35	34	30	32	38	41	39	32	27	24	34
Framingham,	10	17	10	7	10	15	9	19	14	13	16	11
Franklin,	5	6	9	7	5	6	7	5	5	5	5	1
Gardner,	17	14	13	12	8	11	11	12	12	11	6	15
GLOUCESTER,	23	22	36	22	27	28	29	36	26	23	17	22
Grafton,	7	10	11	6	9	4	5	5	6	7	6	8
Greenfield,	5	6	16	15	8	11	5	13	11	9	10	6
HAVERHILL,	42	42	47	62	40	42	47	45	37	37	35	41
HOLYOKE,	72	84	67	52	74	80	103	69	52	63	61	50
Hudson,	2	4	15	3	7	4	4	7	14	4	6	5
Hyde Park,	19	19	21	13	16	15	18	22	13	17	18	13
LAWRENCE,	86	77	95	80	84	69	134	110	90	88	96	78
Leominster,	13	10	18	11	11	4	10	8	18	16	6	19
LOWELL,	144	155	173	117	153	125	174	201	162	154	145	152
LYNN,	88	91	98	86	81	72	65	95	99	84	68	61
MALDEN,	35	38	45	40	39	30	36	59	49	34	26	32
Marblehead,	12	8	19	14	10	13	7	16	12	9	8	13
MARLBOROUGH,	20	18	17	14	16	14	30	30	24	13	8	9
MEDFORD,	22	18	19	18	15	18	22	26	14	6	14	24
Melrose,	16	17	22	12	14	11	14	19	19	6	15	15
Methuen,	3	6	12	7	4	6	10	13	10	12	4	6
Middleborough,	6	7	10	8	5	6	6	9	9	13	4	5
Milford,	24	11	17	21	12	17	12	15	10	17	5	13

TABLE III. — *Concluded.*

	January.	February.	March.	April.	May.	June.	July.	August.	September.	October.	November.	December.
Millbury,	8	3	8	5	3	7	7	6	5	4	10	4
Milton,	7	7	11	9	3	4	5	9	7	10	4	8
Montague,	6	6	9	8	7	13	4	9	12	6	11	7
Natick,	12	13	20	12	7	9	9	14	13	10	14	5
NEW BEDFORD,	117	88	142	93	118	79	178	103	94	111	76	76
NEWBURYPORT,	27	14	21	19	16	21	18	24	18	18	19	17
NEWTON,	28	34	36	44	41	31	45	50	35	43	30	30
NORTH ADAMS,	27	20	34	19	25	20	26	54	22	35	22	29
NORTHAMPTON,	33	16	36	22	21	22	23	34	29	26	22	38
North Attleborough,	8	7	6	9	2	6	5	6	9	9	4	7
Northbridge,	12	4	11	8	12	2	5	19	16	13	12	12
Orange,	5	5	9	9	7	7	2	4	8	5	10	4
Palmer,	14	9	10	10	11	6	7	10	8	9	12	10
Peabody,	14	21	14	18	20	12	12	21	10	26	24	15
PITTSFIELD,	29	21	32	27	22	17	25	37	28	25	21	15
Plymouth,	6	14	13	7	11	5	9	13	19	17	19	19
QUINCY,	32	29	36	37	26	23	19	38	34	24	28	28
Revere,	11	8	10	11	9	14	20	17	13	11	10	15
Rockland,	10	8	6	10	7	3	6	5	8	5	7	9
Rockport,	11	6	6	5	2	6	5	5	9	8	6	8
SALEM,	48	63	64	47	50	43	41	79	45	41	43	30

SOMERVILLE,	52	57	99	72	74	65	83	84	68	69	71	65
Southbridge,	11	13	14	10	11	8	17	15	18	15	11	16
Spencer,	10	11	13	8	10	6	11	12	6	10	6	11
SPRINGFIELD,	60	83	98	81	83	72	103	87	62	88	56	78
Stoneham,	10	6	19	5	5	5	9	7	7	8	10	5
Stoughton,	9	5	10	7	4	11	9	10	11	5	5	3
TAUNTON,	43	59	46	53	50	44	62	66	52	27	48	43
Wakefield,	14	9	10	15	5	8	13	19	22	10	16	5
WALTHAM,	16	20	40	24	23	25	23	31	23	21	18	24
Ware,	7	6	15	15	5	9	13	11	17	12	11	11
Watertown,	8	12	7	6	12	8	10	11	9	13	7	11
Webster,	8	16	15	12	19	10	15	11	12	12	9	14
Westborough,	7	11	24	9	14	11	12	11	16	6	6	11
Westfield,	14	12	11	15	10	10	12	13	15	15	10	17
West Springfield,	10	13	13	6	9	6	12	11	8	8	9	11
Weymouth,	22	16	29	19	15	14	10	12	17	11	19	11
Whitman,	9	9	8	9	10	4	4	5	2	2	6	3
Williamstown,	8	4	10	11	4	4	4	3	8	6	2	4
Winchester,	7	6	3	9	5	4	6	9	8	7	6	6
WOBURN,	20	18	22	22	28	11	20	32	14	29	16	19
WORCESTER,	162	154	158	143	117	118	172	188	153	157	131	138
Totals,	3,322	3,198	3,778	3,336	3,136	2,729	3,602	3,805	3,255	3,101	2,792	2,865

TABLE IV.

Deaths from Specified Causes in Cities and Towns having more than 5,000 Inhabitants in Each.

	Consumption.	Measles.	Scarlet-fever.	Diphtheria and Croup.	Whooping-cough.	Typhoid Fever.	Cerebro-spinal Meningitis.	Erysipelas.	Puerperal Fever.	Influenza.	Malarial Fever.	Cholera Infantum.	Dysentery.	Diarrhœa and Cholera Morbus.	Pneumonia.	Bronchitis.	Diseases of the Heart.	Diseases of the Brain and Spinal Cord.	Diseases of the Kidneys.	Cancer.	Suicide.	Accident.	Unknown or Ill-defined Causes.	All Other Causes.
Adams,	16	-	1	9	-	4	4	1	1	-	-	17	4	6	25	8	20	12	10	8	2	2	1	28
Amesbury,	27	-	1	3	-	2	1	1	-	-	-	5	3	6	8	5	16	37	8	12	-	1	-	3
Andover,	7	1	-	4	-	3	1	-	-	-	-	-	-	1	6	4	10	7	6	2	1	3	-	32
Arlington,	17	1	-	2	-	1	4	1	-	-	-	11	-	-	16	4	13	25	3	5	1	2	-	35
Athol,	9	-	2	3	-	-	2	3	-	-	-	1	-	-	13	4	12	-	3	3	-	2	-	52
Attleborough,	14	-	-	4	-	-	3	-	-	-	-	-	-	-	15	-	8	21	5	6	-	11	-	49
BEVERLY,	19	1	-	2	-	4	3	-	-	-	-	12	2	2	17	1	23	7	15	9	4	6	-	42
Blackstone,	7	-	-	1	-	1	8	1	1	-	-	8	-	-	16	5	5	3	9	3	-	11	48	-
BOSTON,	1,289	21	136	455	39	173	185	32	13	34	1	400	18	104	1,236	376	913	590	409	400	92	451	57	3,713
Braintree,	7	1	2	3	-	1	4	-	-	-	-	3	-	-	15	-	11	15	2	1	1	2	42	-
BROCKTON,	60	2	4	22	3	4	3	-	-	-	2	15	5	-	32	9	37	39	9	18	1	8	2	198
Brookline,	16	-	-	5	-	2	2	-	-	-	-	3	-	-	22	6	15	14	8	14	1	1	-	94
CAMBRIDGE,	197	3	10	51	17	11	20	4	2	19	1	103	4	83	103	54	100	181	70	46	8	39	161	240
CHELSEA,	87	1	1	13	7	6	10	4	1	2	-	20	4	4	68	28	64	8	5	23	3	4	-	287
CHICOPEE,	33	1	-	28	2	5	3	1	-	1	2	33	-	3	18	5	15	40	17	2	2	8	6	136
Clinton,	24	-	1	1	-	-	1	-	-	1	-	15	3	4	14	3	13	28	2	2	-	3	-	46
Concord,	3	-	1	1	-	1	-	-	-	4	-	-	-	-	2	1	5	3	2	2	2	3	-	18
Danvers,	10	-	1	3	-	2	-	1	1	-	-	2	1	4	17	3	15	16	13	9	-	1	13	-
Dedham,	18	-	-	3	3	-	5	5	2	-	-	-	3	1	14	3	19	12	4	1	1	6	5	17
EVERETT,	35	2	5	25	8	4	8	1	-	5	-	22	2	2	36	10	40	34	7	19	1	2	-	95
FALL RIVER,	168	9	6	29	11	32	3	7	-	4	3	193	-	25	185	112	67	296	102	50	-	50	23	760
FITCHBURG,	35	1	-	14	1	4	3	-	-	5	-	23	-	3	37	13	49	39	9	14	5	7	-	152
Framingham,	14	1	-	6	1	2	2	-	-	-	-	4	-	-	25	-	13	6	4	1	1	4	4	63

Franklin, . . .	5	-	-	-	-	1	1	-	-	-	-	3	-	3	6	1	8	10	2	5	-	3	8	10
Gardner, . . .	16	-	1	1	1	2	2	-	-	2	-	4	2	1	5	3	5	13	11	7	-	5	-	61
GLOUCESTER, . .	40	-	-	4	1	1	1	1	3	-	-	16	-	4	23	3	47	43	10	16	1	18	-	78
Grafton, . . .	2	-	-	3	-	-	-	-	-	-	-	1	-	-	11	-	9	1	1	1	-	3	-	52
Greenfield, . .	7	-	2	2	-	2	6	-	2	-	-	2	-	-	9	7	9	1	-	8	-	8	-	50
HAVERHILL, . .	79	1	5	20	1	16	1	3	1	8	-	11	-	4	52	18	40	60	18	32	2	17	3	123
HOLYOKE, . . .	47	6	2	2	2	3	23	1	1	1	2	54	7	8	27	8	15	9	3	4	1	8	-	593
Hudson, . . .	14	-	1	1	-	2	1	-	-	4	-	6	-	-	4	3	7	10	3	3	-	-	-	16
Hyde Park, . .	22	1	1	7	1	2	11	2	3	2	-	12	2	2	16	6	12	8	4	5	2	3	-	79
LAWRENCE, . .	65	-	11	31	1	9	1	1	1	4	1	123	4	12	109	25	71	47	16	27	4	21	15	488
Leominster, . .	16	-	-	7	-	2	4	-	-	2	-	3	2	-	7	3	8	1	4	10	1	5	-	68
LOWELL, . . .	187	9	2	41	11	18	9	2	1	27	-	177	3	17	173	103	166	255	54	46	2	54	1	497
LYNN, . . .	81	4	2	20	8	19	40	-	-	23	2	36	2	2	79	34	76	8	2	43	2	8	8	489
MALDEN, . . .	53	1	1	16	5	4	6	1	1	1	-	36	4	7	50	14	61	36	31	24	1	11	1	98
Marblehead, . .	21	1	-	2	-	2	6	-	2	-	-	2	-	9	13	3	26	12	7	2	1	5	-	27
MARLBOROUGH, .	25	-	-	1	3	1	2	-	-	2	-	23	19	1	16	3	20	12	3	3	1	-	-	77
MEDFORD, . .	13	2	-	-	1	1	-	-	-	-	-	13	1	-	26	7	19	-	4	6	-	6	-	117
Melrose, . . .	19	3	-	4	2	2	3	-	-	-	-	7	2	-	23	4	19	1	2	-	-	1	12	76
Methuen, . . .	7	-	-	1	-	3	3	-	-	2	-	5	3	1	6	1	10	5	1	2	-	2	2	39
Middleborough, .	5	-	-	-	-	1	-	-	-	-	-	-	4	-	1	2	17	1	-	2	-	2	7	46
Milford, . . .	25	-	1	1	-	3	3	-	-	1	1	10	2	2	18	1	29	16	11	5	2	2	-	41
Millbury, . . .	10	-	-	5	-	1	-	-	-	-	-	1	1	3	4	6	6	5	-	1	-	1	-	26
Milton, . . .	14	-	1	1	-	-	-	-	-	-	-	3	1	1	9	2	9	-	6	2	-	3	-	31
Montague, . . .	13	1	-	1	-	-	1	-	-	2	-	6	8	-	18	2	2	16	4	1	-	7	3	13
Natick, . . .	15	-	1	4	-	1	3	-	1	-	-	9	1	-	8	5	15	-	5	6	3	1	-	60
NEW BEDFORD, .	91	5	13	47	1	23	2	2	2	1	1	120	4	9	129	45	97	3	53	32	2	-	12	581
NEWBURYPORT, .	17	-	-	7	-	5	-	-	-	1	-	5	-	3	10	9	22	8	5	10	-	7	1	122
NEWTON, . . .	43	-	5	12	-	5	6	1	-	1	-	20	1	2	41	10	34	33	19	21	1	17	-	175
NORTH ADAMS, .	27	-	2	21	2	10	1	-	-	7	-	34	1	1	29	9	19	13	2	7	2	10	-	134
NORTHAMPTON, .	33	-	1	21	-	3	-	-	1	-	3	10	2	-	29	11	27	6	8	11	3	11	-	142
North Attleborough,	9	-	-	1	-	2	-	2	-	1	-	-	-	-	5	-	13	11	4	2	1	4	-	23
Northbridge, . .	13	-	-	3	1	6	4	-	1	2	3	21	-	1	13	3	10	4	2	4	-	6	-	29
Orange, . . .	10	-	-	-	-	1	1	-	-	-	-	2	-	-	7	1	11	2	6	7	2	1	-	24

TABLE IV. — *Concluded.*

	Consumption.	Measles.	Scarlet-fever.	Diphtheria and Croup.	Whooping-cough.	Typhoid Fever.	Cerebro-spinal Meningitis.	Erysipelas.	Puerperal Fever.	Influenza.	Malarial Fever.	Cholera Infantum.	Dysentery.	Diarrhœa and Cholera Morbus.	Pneumonia.	Bronchitis.	Diseases of the Heart.	Diseases of the Brain and Spinal Cord.	Diseases of the Kidneys.	Cancer.	Suicide.	Accident.	Unknown or Ill-defined Causes.	All Other Causes.
Palmer, ...	10	-	-	2	-	2	-	-	-	-	-	1	-	-	12	1	9	-	1	3	-	1	-	74
Peabody, ...	25	1	-	18	1	4	-	1	1	2	-	11	1	-	23	8	11	12	2	4	-	4	-	78
PITTSFIELD, . .	25	-	-	7	1	3	2	-	2	1	17	-	-	1	38	13	22	25	14	14	1	12	-	101
Plymouth, . . .	15	-	1	3	3	-	4	1	-	1	-	4	1	1	4	4	21	7	5	9	3	3	20	42
QUINCY, ...	46	3	2	3	-	6	3	-	-	4	-	14	3	-	41	8	27	55	11	7	3	16	-	102
Revere, ...	11	-	-	4	-	1	10	-	-	2	-	5	1	-	12	2	11	5	5	6	-	14	20	40
Rockland, . . .	8	-	-	-	2	-	1	1	-	1	-	2	5	1	11	1	13	10	7	5	-	4	5	7
Rockport, . . .	11	-	2	1	-	-	-	-	-	-	-	3	-	2	4	-	2	8	2	3	-	6	6	27
SALEM, ...	47	-	4	15	-	6	3	1	-	-	-	19	2	8	49	23	58	25	33	16	4	15	-	266
SOMERVILLE, . .	67	3	6	47	4	11	52	2	-	14	-	45	4	9	104	17	64	9	33	22	1	18	-	326
Southbridge, . .	15	-	-	6	-	2	9	-	1	1	-	15	3	2	4	6	7	4	13	3	1	1	15	51
Spencer, ...	9	-	-	4	-	1	1	-	1	1	1	9	3	11	10	-	8	4	4	5	1	3	-	38
SPRINGFIELD, . .	108	6	4	26	5	15	5	4	4	15	3	75	6	8	74	29	72	60	61	45	9	31	10	275
Stoneham, . . .	16	-	-	-	-	1	7	-	-	3	-	-	1	1	8	5	10	11	6	3	1	1	5	17
Stoughton, . . .	11	-	-	4	-	-	4	-	-	3	-	3	1	2	6	-	11	16	5	3	-	1	-	19
TAUNTON, . . .	59	2	4	10	1	6	-	1	-	7	3	23	2	6	50	18	36	8	15	11	3	1	-	322
Wakefield, . . .	17	-	3	6	-	2	14	-	-	-	-	5	-	1	10	2	12	35	4	4	2	6	1	22
WALTHAM, . . .	31	-	2	6	-	2	-	-	-	-	-	3	2	-	23	4	34	33	15	14	1	7	-	111
Ware, ...	9	2	-	3	-	-	3	-	-	1	-	16	1	4	10	6	12	5	5	1	1	6	2	45
Watertown, . . .	17	2	7	7	-	1	7	1	1	-	1	3	-	2	10	3	11	5	2	7	1	3	23	-
Webster, ...	14	1	6	3	-	1	3	-	-	5	-	11	-	5	13	2	15	22	6	3	-	5	-	38
Westborough, . .	9	1	1	4	-	-	-	-	-	1	-	2	-	-	4	5	16	53	5	11	1	4	21	-
Westfield, . . .	19	-	-	2	-	4	-	-	-	1	-	4	-	-	12	4	16	9	5	7	1	5	3	62

West Springfield, . .	18	-	2	7	1	2	4	-	-	1	1	7	1	3	7	1	9	4	6	3	-	12	-	27
Weymouth, . .	19	1	4	4	1	3	5	-	-	1	-	2	-	4	8	7	31	26	6	17	1	2	24	29
Whitman, . . .	14	1	-	-	-	-	2	-	-	-	-	1	-	-	4	2	8	2	2	-	-	-	-	35
Williamstown, . .	8	-	1	3	-	4	-	-	-	-	-	2	1	1	9	5	6	2	3	2	1	3	-	17
Winchester, . .	9	-	3	5	-	1	1	-	-	-	-	3	1	-	12	2	8	8	-	4	2	1	-	16
Woburn, . . .	35	3	-	5	2	3	1	-	-	2	-	6	2	2	25	10	24	24	2	1	1	2	1	100
Worcester, . .	228	17	8	58	1	15	-	5	8	1	2	125	5	14	181	54	179	274	78	60	11	57	4	403
Totals, . .	4,086	122	283	1,237	155	509	557	95	59	237	50	2,084	171	429	3,694	1,248	3,185	2,844	1,379	1,298	210	1,121	595	13,235

Homicide.	
Boston,	14
Cambridge,	1
Concord,	1
Haverhill,	2
Hyde Park,	1
Leominster,	1
Marlborough,	1
Milton,	1
North Adams,	2
Springfield,	1
Worcester,	3
Total,	28

Actinomycosis.	
Boston,	2

Glanders.	
Boston,	1
Cambridge,	1
Total,	2

Small-pox.	
Cambridge,	2
Gloucester,	1
Somerville,	1
Total,	4

TABLE V.

Deaths from Specified Causes, 1897. Death Rates per 10,000 (1894–97). Deaths per 1,000 from All Causes (1894–97).

CAUSES OF DEATH.	Deaths, 1897.	MORTALITY PER 10,000 OF THE POPULATION.				DEATHS PER 1,000 FROM ALL CAUSES.			
		1897.	1896.	1895.	1894.	1897.	1896.	1895.	1894.
Consumption,	4,086	19.01	20.60	21.19	22.34	105.00	106.75	110.45	113.64
Measles,	122	0.57	0.53	0.45	0.35	3.13	2.72	2.33	1.79
Scarlet-fever,	283	1.32	1.06	2.08	2.95	7.27	5.50	10.84	15.01
Diphtheria and croup,	1,237	5.75	7.20	7.88	9.21	31.78	37.30	41.05	46.82
Whooping-cough,	155	0.72	1.01	1.04	1.88	3.98	5.22	5.42	9.54
Typhoid fever,	509	2.37	2.77	2.66	3.20	13.08	14.33	13.88	16.29
Cerebro-spinal meningitis,	557	2.59	1.54	1.81	1.49	1.43	0.80	0.94	0.76
Erysipelas,	95	0.44	0.52	0.55	0.51	2.44	2.70	2.86	2.60
Puerperal fever,	59	0.27	0.37	0.41	0.53	1.52	1.91	2.14	2.71
Influenza,	237	1.10	0.52	1.73	1.28	6.09	2.67	9.01	6.53
Malarial fever,	50	0.23	0.28	0.26	0.28	1.28	1.44	1.37	1.44
Cholera infantum,	2,084	9.69	13.22	10.69	12.92	53.55	68.52	55.73	65.74
Dysentery,	171	0.79	1.48	0.80	0.87	4.39	7.65	4.15	4.42
Diarrhœa and cholera morbus,	429	2.00	2.47	2.08	2.53	11.02	12.80	10.86	12.84
Pneumonia,	3,694	17.18	17.76	17.51	16.21	94.92	92.04	91.28	82.46
Bronchitis,	1,248	5.81	6.04	6.16	6.61	32.07	31.31	32.09	33.63
Diseases of the heart,	3,185	14.81	15.35	15.44	14.62	81.84	79.53	80.47	74.38
Diseases of the brain and spinal cord	2,844	13.23	12.41	13.31	14.14	73.08	64.31	69.37	71.90
Diseases of the kidneys,	1,379	6.42	6.87	6.96	6.48	35.43	35.62	36.27	32.98
Cancer,	1,298	6.04	6.12	4.47	5.92	33.35	31.73	23.29	30.11
Suicide,	210	0.98	1.06	1.06	0.89	5.40	5.50	5.55	4.52
Accident,	1,121	5.21	5.68	5.81	5.40	28.80	29.42	30.30	27.48
Unknown or ill-defined causes,	595	2.77	3.15	2.38	2.02	1.53	1.63	1.24	1.03
ALL CAUSES,	38,919	18.10	19.30	19.19	19.66	-	-	-	-

The population upon which the foregoing death rates are calculated is estimated for 1897 by the usual rule, from the rate of increase in the foregoing five-year period (1890–95).

HEALTH OF TOWNS.

HEALTH OF TOWNS.

The following abstract has been compiled from the reports of local boards of health, and contains the principal points of sanitary interest, selected from those reports which have been forwarded to the office of the State Board.

Adams.

Heretofore, many cases which were very mild and would hardly be regarded as diphtheria have not been reported to the board, but under the present system of diagnosing cases, by the use of culture tubes, all cases, whether mild or severe, are reported.

The board has taken every precaution during the past year to prevent the spreading of contagious diseases, and twice resorted to closing the schools, which resulted each time in a very decided decrease in the spread of the disease.

The keeping of swine within the fire district has resulted in so many and such frequent complaints against this nuisance that the board has been compelled to take action, and has made the following regulation: —

All persons are hereby forbidden to keep swine within the limits of the fire district, in the town of Adams, Mass., on and after April 1, 1898, except those having a special license for the keeping of the same. The board reserves the right to revoke the license for the keeping of said swine at any and all times, when the rules and regulations for the keeping of said swine are not complied with.

The board recommends that the town erect a slaughter house, and charge each licensed butcher a nominal sum for slaughtering there.

Amesbury.

We point with a great amount of pride to the fact that the milk supply of Amesbury at the present time is of an exceedingly high order. The regulation pertaining to the milk supply met with a willing response from all the producers except two out of town. One of these thought better of it later, and complied with the request. The other was brought into court and fined. He appealed to the superior court. He pleaded guilty in the superior court, and his case was placed on file.

The question of how to dispose of the dead bodies of animals killed by order of the State still comes up for consideration. This board recommends that a small appropriation be voted to either erect or secure the use of a small slaughter house where this work can be done. A small furnace is necessary to cremate the viscera of these animals.

All unhealthy cows found by the inspector in New Hampshire were disposed of so that the milk should not be sold in Amesbury.

Diphtheria. — A little more than twenty-five per cent. of those cases treated without antitoxin proved fatal. Of those treated with antitoxin, one hundred per cent. recovered.

Arlington.

During the past year the town has been singularly free from any epidemic of contagious disease.

Our statistics show that in 1894 there were reported 13 cases of diphtheria and 37 cases of scarlet fever; in 1895, 40 cases of diphtheria and 20 cases of scarlet fever; in 1896, 20 cases of diphtheria and 7 cases of scarlet fever; in 1897, 8 cases of diphtheria and 10 cases of scarlet fever. During these four years the population of the town has steadily increased, while the number of cases of diphtheria and scarlet fever has steadily decreased.

Attleborough.

It has been our custom not to require the head of the family or other members working in shops to remain at home or absent themselves from their various vocations, provided the sick person is kept in an apartment away from the living rooms, and that they have nothing to do with the care of the patient. This rule has worked well and will be followed by us, unless, as a result of carelessness or otherwise, the health of the community seems to be imperilled.

The almost universal use by physicians of the antitoxin serum in the treatment of diphtheria has robbed that disease largely of its terrors. Early in the year the local board availed itself of the offer of the State Board to furnish free to towns this serum, and we have had kept in one of the drug stores in town a supply sufficient to furnish this wonderful agent for immediate use by physicians. Forty-five bottles were used during the year. This action of the State Board seems to us to be of the greatest benefit to the community, and we trust that they will continue to furnish this valuable remedy, which otherwise, from its great cost, would be almost denied many people.

Beverly.

We have introduced the new formaldehyde gas generator for fumigating, and find it very satisfactory.

Boston.

The total number of deaths for the year was 11,154, a decrease from the previous year of 480 deaths. The death rate for the year, as calculated on an estimated population of 528,912, was 21.08 per 1,000 inhabitants. This rate is less by 1.45 than that of the previous year, and the lowest since 1879.

Infant Mortality. — The percentage of deaths under one year in 1885 was 30.0; in 1890 the percentage was 26.78, and in 1895, 26.35. A table has been constructed on the following method, which is generally admitted to be accurate, viz., deaths under one year of age to 100 births. The decrease in this table is notable.

Deaths under One Year of Age, to each 100 Births.

	Years.														
	1883.	1884.	1885.	1886.	1887.	1888.	1889.	1890.	1891.	1892.	1893.	1894.	1895.	1896.	1897.
Percentages,	19.1	19.3	18.6	17.5	18.8	17.8	18.2	17.0	17.5	16.2	17.2	16.5	16.5	16.3	14.7

Medical Inspection of Schools. — The number of cases of infectious diseases found in the schools during 1897 has been less than in previous years, as would be expected in the great falling off in the total cases in the city. The attention and watchfulness of the inspectors, however, have continued, and with marked effect, not only in pointing out a large number of cases and causes of sickness, but in creating a larger interest in the physical welfare of the school children.

Summary of Reports of Medical Inspectors of Schools for 1897.

Specific infectious diseases,	495
Oral and respiratory diseases,	3,638
Diseases of the ear,	91
Diseases of the eye,	489
Diseases of the skin,	2,775
Miscellaneous diseases,	5,289
Total number of examinations,	12,777
Number recommended to be sent home,	2,781
Number of consultations with teachers (about pupils returning to school),	927

Lodging-houses. — The personal experience of the board of health warrants the conclusion that, to measurably check the fostering of immoral and unclean habits of men and their crowding into ill-fitted and dangerous buildings, as well as for the welfare of the better disposed, it is necessary to make and enforce wholesome regulations for the construction, equipment and care of all cheap lodging-houses, and to this end the following rules and regulations have been adopted: —

1. The means for light and ventilation shall be satisfactory to the board of health, and beyond the control of lodgers.

2. All floors and stairways shall be sound, smooth, and either painted or shellacked.

3. There shall be allowed not less than three hundred cubic feet of space to each lodger in sleeping-rooms.
4. Open and spacious dormitories shall be preferred.
5. Single or small rooms shall be allowed only in exceptional cases, and then only with fireproof partitions.
6. No carpeting shall be allowed on floors or stairways.
7. There shall not be less than two horizontal feet between the sides of any two beds.
8. All bedsteads shall be single, and of iron.
9. Blankets shall be required and "comforters" shall be prohibited.
10. Mattresses shall be covered with a waterproof covering.
11. No person shall be allowed to retire or sleep in his day clothing.
12. No person who is not clean shall be allowed to retire without a bath.
13. Water-closets (one to every twenty lodgers), lavatories and shower-bath, with hot and cold water, all with open plumbing, shall be furnished on each floor, and the floors to same shall be of marble, slate or concrete.
14. All movable receptacles for excretions are prohibited.
15. Smoking in sleeping-rooms is prohibited.
16. All stairways, fire-escapes and other means of exit in case of fire shall be in accordance with the statutes and ordinances on that subject, and to the satisfaction of the building commissioner.
17. Stoves for heating shall be allowed only under the most favorable conditions for safety.
18. The use of portable kerosene lamps is prohibited.
19. A reliable person or persons shall be in attendance at all hours of the night.

Disinfection. — The amount of disinfection in dwellings during the past year has fallen off somewhat, owing to the smaller number of cases of diphtheria and scarlet fever, while the care and completeness of this work has been greatly improved, and our means for finding and dealing with infectious diseases have largely increased and been rendered more effective. The new agent, formaldehyde gas, which was put in use here in January, 1896, and mentioned in our last annual report, has proved sufficiently effective to warrant its general use as a surface disinfectant in place of the sulphur-dioxide process. The steam plants for disinfection in the city and at quarantine have been continued in active use, as have also been the bichloride of mercury and the chloride of lime. The following table presents a list of the diseases and of the infected articles and places for which this work has been done : —

Diphtheria,	2,984
Scarlet-fever,	1,583
Measles,	10
Phthisis,	13
Small pox,	11
Glanders,	107

Miscellaneous,	4
Infected bedding, etc. (lots),	42
Infected clothing (lots),	29
Infected books, etc. (lots),	11
Infected carriages (lots),	7
Infected schools (lots),	3
Rooms disinfected,	9,477

Garbage and Refuse Disposal. — The board is gratified in being able to state that the outlook for the erection of plants by the city for greatly improved methods of disposal of garbage and other refuse of the city is good. The proposed reduction plant at "Calf Pasture" would do away with several serious garbage nuisances in the city, and the proposed incinerating plant for the combustible refuse, on Albany Street, would abate a nuisance at Fort Hill wharf, and relieve the harbor and beaches of collections of most obectionable materials.

Bakeries. — Under the law governing bakeries, 344 of them have been examined, and alterations made so as to comply with the law. All water-closets have been removed from the bakeries and wash-rooms provided. In all cases where there was direct communication between stables and bakeries, partitions have been built and direct communication cut off. All bakeries have been whitewashed once in three months, according to the law. In two instances the owners of bakeries which were connected with stables were obliged to remove their horses to other places, as satisfactory alterations could not be made within their establishments.

Public Baths. — There were eighteen bath-houses in operation during the year 1897, which were used by the public to the extent shown in the following summary : —

	1896.	1897.
Total men and boys,	611,894	536,360
Total women and girls,	189,341	120,915
Total of both sexes,	801,235	657,275

Stables. — The number of applications for the occupation of stables during the year was 257. Of this number, 198 were granted, 36 were refused, 8 were withdrawn and 15 are awaiting action.

Extracts from Reports of Medical Inspectors.

During the past year 459 persons dying without a physician in attendance have been reported to this office. In all these cases a personal visit has been made, the body examined, and a probable diagnosis made before granting a permit for burial. Five cases were referred to the medical examiner for investigation.

Infectious Diseases. — Twenty-four cases of eruptive diseases, reported as small-pox, have been examined during the year. Ten of these were found to be small-pox. In these cases prompt isolation, removal to the hospital, disinfection of the premises and vaccination of those that had been exposed prevented any spread of the disease.

Three thousand three hundred and ninety-eight cases of diphtheria and 1,938 cases of scarlet fever were reported the past year. Each case has been investigated, and a report made whether or not the case was properly isolated. In many cases isolation was not approved, and these cases were sent to the hospital, and when necessary an order was obtained for a forcible removal.

Three thousand one hundred and fifty-six persons have been vaccinated; 1,220 persons have received certificates of vaccination, such persons having returned and proven themselves entitled to certificates.

Animals killed at Abattoir.

Cattle,	21,020
Calves,	16,217
Sheep,	55,040
Swine,	6,969
Total,	99,246

Animals condemned.

	Number.	Weight (Pounds).
Cows,	68	27,258
Steers,	1	740
Bulls,	3	1,540
Calves,	1	43
Sheep,	–	–
Swine,	6	950
Parts of animals,	–	1,500
Total,	79	32,031

Diseases found among Animals after having been killed and dressed at the Abattoir, necessitating the Condemning of the Carcasses.

Diseases.	Cattle.	Calves.	Sheep.	Swine.
Tuberculosis,	70	–	–	–
Texas fever,	1	–	–	–
Puerperal fever,	1	–	–	–
Hog cholera,	–	–	–	6
Immatured,	–	1	–	–
Total,	72	1	–	6

Tuberculosis. — The following table shows the percentage of tuberculosis in cattle killed at the abattoir: —

Class of Animals.	Number Received.	Tuberculosis.	Percentage.
Whole number of all kinds, ...	21,020	70	0.333
Cows from eastern States, ...	2,044	66	3.229
Bulls from eastern States, ...	250	3	1.200
Steers from eastern States, ...	–	1	–
Cows from western States, ...	333	–	–
Steers from western States, ...	18,392	–	–

Under the head of "Cows from eastern States" is understood those animals from all of the New England States, including Massachusetts.

Glanders. — There has been reported to the board of health during the past year 175 horses under the suspicion of having glanders or farcy. Of these, 19, on examination, were found to be affected with some other disease, 3 could not be found, and 153 proved to have glanders, and were at once reported to the Board of Cattle Commissioners. Of the 153 cases of glanders, 8 were animals which were found in Boston, but which belonged in some other city, and had never been in any stable in this city.

Rabies. — During the past year eight dogs have died within the city with symptoms suspicious of rabies. One dog which had always been kept with two of the above dogs that had died was placed in quarantine for ninety days, and at the expiration of that time it was released from quarantine, as no symptoms of rabies had appeared. A dog which had been bitten by a rabid dog was ordered killed, as the method of quarantine was insufficient, and several small children were thereby exposed to this animal.

Bridgewater.

Early in February two cases of scarlet fever occurred in the normal boarding hall. These cases were quarantined within the building, and every precaution taken to prevent the spread of the disease; nevertheless, from previous exposure, several more cases developed, and it was thought best to close the school for weeks, to prevent the further spread of the disease. Meanwhile great care was taken to prevent contagion in the model school. The teachers were sent away from Normal Hall to board, and all observing by students of the normal school was for the time prohibited. These protective measures were successful, and no case of scarlet-fever occurred in the model school.

On the return of the normal pupils at the end of two weeks it was found necessary to provide for some of the convalescents who were not yet ready to be released from quarantine, and a house was taken on Mt. Prospect

Street to be used as a hospital. To this house these patients were removed. Subsequently other cases which occurred were immediately transferred to the hospital. In this way, after much anxiety and inconvenience, the spread of the disease was checked. The whole number of cases in connection with the normal school was nineteen.

Brockton.

The death rate for the year, as calculated on a population of 35,853 (the State Board of Health's estimate), was 13.19 per 1,000 inhabitants. This rate is less by 4.95 than that of the previous year, and the lowest with one exception for nine years.

The board is of the opinion that the final disinfection of the premises where there have been contagious diseases, to be done in a thorough and reliable manner, should be done by a person under the immediate supervision of the board.

Nearly two hundred estates were connected with the public sewer the past year.

Brookline.

With a population of 18,147, 206 deaths give a mortality of only 11.18 per 1,000 inhabitants for 1897.

As an important aid to a correct diagnosis in cases of fever suspected by the physician to be typhoid, the board has arranged for free bacteriological examinations, which compare favorably in point of accuracy with those provided by the board for the diagnosis of tuberculosis and diphtheria.

It is believed this test, the "Widal reaction," will be most useful in the detection of light or "walking cases" of typhoid, the class of cases that are most dangerous in spreading the disease, because undetected and at large, and perhaps engaged in the milk business.

Intermittent fever (malaria) has been less prevalent the past year than during the previous few years. Circulars of inquiry sent to all practising physicians in the town and to those living just beyond the limits brought out the fact that during the year about fifty typical cases had been met with.

The board's hospitals for diphtheria and scarlet fever were in use a considerable part of the year for the prompt isolation and care of the very first cases appearing in tenements or other crowded buildings, thus doing much to prevent the spread of these dangerous but more or less preventable diseases, and at the same time enabling many children to continue in school, who otherwise, though well, must have remained out for many weeks. The free bacteriological examinations provided by the board for the early and accurate diagnosis of diphtheria have been very extensively availed of, and with great benefit to the patients and their families.

In April formaldehyde disinfection of rooms after scarlet fever and diphtheria was adopted, and since that time has been in successful use.

The subject of the prevention of tuberculosis, the disease which destroys more lives than all other communicable diseases combined, has recently received serious attention. As a result, the board printed a revised and abridged circular of the Massachusetts State Board of Health on the nature and prevention of that disease, and ordered a copy to be sent to every family in town.

The need of improved public bathing facilities, often urged in previous reports of this board, has been fully met by the new public bath-house, over 45,000 baths having been taken there the past year.

During the past year the number of examinations made in the laboratory has been nearly double that for the year preceding, and the scope of the work has been increased to include analysis of butter as well as milk and vinegar.

Cambridge.

Complaints investigated and nuisances abated during the year,	776
Number of inspections made,	3,023
Number of subsequent inspections,	4,180
Total,	7,203

In view both of the present situation and the future, the city has no more pressing need than an adequate hospital for cases of infectious diseases, and we earnestly urge that a site be at once secured and such a hospital established.

The medical inspection of schools has been continued through the year on the same lines as in the year 1896.

The diseases discovered in the schools during 1897, and the number of cases of each disease, are given below: —

Chicken-pox,	21
Diphtheria,	2
Measles,	19
Mumps,	8
Pediculosis,	53
Phthisis,	1
Scarlet-fever,	4
Whooping-cough,	13
Diseases of ear,	4
Diseases of eye,	28
Diseases of skin,	17
All other diseases,	42
Total,	212

The number reported shows an increase of 41 cases over the number reported in 1896.

The report on ice made to us by the inspector of milk shows that the condition, fraught with danger to the health of the community, which existed a year ago, and on which we commented at length in our report for 1896, still continues in existence.

With a view to the abatement of the dangerous and filthy practice of spitting in street cars, a practice confined almost entirely to men, the board, at a meeting held July 28, passed the following regulation: —

The board of health of this city hereby adjudges spitting in street cars to be a public nuisance, source of filth and cause of sickness, and prohibits such spitting upon the floor, platform or any other part of any street car.

Canton.

We again repeat what we said in our report of last year in reference to sewerage in the thickly settled portions of the village, as it is a matter that will very soon demand serious thought and attention. We respectfully suggest that this question be given due consideration in the near future.

Chicopee.

The sanitary condition of the city of Chicopee during the year 1897 was better than in former years. The health of a community depends largely on the action of the people, and, unless the people will voluntarily comply with the regulations of the board of health, unsatisfactory work will be the result.

The board recommends the adoption by the city of the collection of all garbage in the most settled parts of the city.

Concord.

Our agent has made a careful inspection of each house and barn within the limits of the town. The condition of the different premises examined varies greatly, as it would be natural to infer. Taken as a whole, however, the situation has improved over the previous year, and exhibits a decided advance in sanitation during the last five years. This is shown in the reduced death rate.

During the past month we have caused another examination of dairy farms to be made, and the conditions found were as a whole not as satisfactory as they should be, and what we have a moral right to demand. About 56 per cent. were found in first-class condition, in regard to light, ventilation and cleanness; 21 per cent. were fair; and 23 per cent. decidedly bad. The first duty of our milk producers must be in the line of greater cleanness.

Danvers.

The greatest question before the board has been, as for a number of years, the disposal of the sewage from the tanneries. This subject has engrossed the attention of the State Board of Health for a number of years

throughout the State, and it is a subject which very properly comes within the sphere of the State Board of Health for a solution. Consequently we have very frequently called upon it for advice as to the best way of remedying the nuisance caused by the sewage from factories emptying into Crane River.

The diphtheria epidemic, which started last year, continued, but has been kept under excellent control by careful isolation of cases. We wish to express our great confidence in the value of the serum treatment of this dread disease. It is evident, to physicians who have used this remedy, that it greatly shortens the duration of the disease, and cures it when administered in season. Failure results only when it is used too late in malignant cases. When administered early, even in the most severe cases, a satisfactory effect is apparent in a short time.

An apparatus for the generation of formaldehyde gas for disinfection has been purchased by the board. It has been found to be of value, and we appreciate it; but there is nothing equal to the thorough cleansing of infected apartments with antiseptic solution, and renewal of paper, paint and whitewash. The careful isolation of patients until all traces of disease have disappeared, together with thorough disinfection of infected apartments, will be insisted upon by the board in all cases.

Dedham.

The sanitary condition of the town during the past year has caused more trouble than in any of the previous years. More complaints from overflowing cesspools, vaults and bad drainage have been received than have ever before been made in any like period. Over 170 complaints have been thus made, and in many cases the remedy is difficult and expensive.

For the proper disposal of our wastes, and protection of the public health, it is essential that the town should take immediate steps toward relief by the construction of sewers.

Everett.

The city is in a better sanitary condition than last year, as many cesspools and vaults have been ordered abolished and the premises connected with the sewer.

The number of deaths from consumption during the year was five less than in 1896. This year there were thirty-five deaths from consumption.

A most important subject that the board has at present under consideration is the milk supplied to the inhabitants of our city. When the board of health is empowered to have authority over the milk supply, we may hope to see milk handled by dealers who are responsible, who have facilities to mix and store their milk in buildings separate from all sources of infection, kept and delivered in receptacles that are thoroughly cleansed, and endorsed by the board of health; and not until then can we hope to obtain milk that is free from pollution.

We recommend that the inspector of milk come under the jurisdiction of the board of health.

Ninety-seven orders have been issued to connect buildings with the sewer. One hundred and one orders to abate nuisances were sent or served.

There were three hundred and fifty-seven cultures taken during the year, and fifty-one houses fumigated.

Fall River.

The system of disinfecting premises visited by contagion, which up to the month of April last year had been done by burning sulphur, using three pounds to each one thousand cubic foot of air space, was then substituted by the use of formaldehyde gas.

By the timely discovery and interference by the board at the beginning of the year, what threatened to assume the proportions of an epidemic of typhoid fever, through carelessness in handling milk by a dealer, was narrowly averted. This dealer used a tenement in a house in which typhoid fever existed as a storage place for milk. Investigation of several cases of the disease disclosed the facts that the families in each case obtained the milk supply from this dealer. The board immediately took possession of the milk and utensils belonging to this dealer, had the milk destroyed, all cans and measures sterilized and the cow barn disinfected, after which no cases attributable to this milk dealer were reported.

By a new regulation, the board has a record kept of the source of the milk supply in every family in which a case of typhoid fever is reported to exist. Provision has also been made to enable physicians to confirm the diagnosis, in all cases of suspected typhoid fever, by the Widal test, outfit and full printed instructions for which can be obtained on application at this office.

The board furnishes culture tubes and outfits for taking cultures on application at the office; and, as this disease demands prompt attention, physicans, parents and guardians of children suspected of having the disease are advised to lose no time in having cultures taken and the true nature of the disease determined.

Three thousand six hundred persons were successfully vaccinated at this office during the year. The following table gives the number vaccinated at this office each year since 1892 : —

1892,	1,326	1895,	2,118
1893,	1,231	1896,	2,001
1894,	1,720	1897,	3,600

A hospital for the isolation of contagious diseases is a necessity which has existed for years and becomes more manifest every succeeding year.

In providing such a hospital, we would recommend having a bacteriological laboratory and public disinfection station attached; that it be located in some sparsely settled section of the city, and sufficient land secured upon which, in case of emergency, temporary buildings could be erected for the accommodation of patients.

Under act of Legislature (1896), constant supervision and periodical inspection of the various bakeries in the city has been exercised and performed.

The inspection of all cattle within the city has been thoroughly made. The carcasses of all animals killed and intended for food have been examined and tagged by the inspector, who attends the slaughter of all such animals, when satisfied that they are free from disease.

Fitchburg.

The report shows a large increase in the amount of work performed during the year in all its departments.

The following regulation in regard to spitting in public places was adopted June 26: "Spitting in public conveyances (street cars, hacks, carriages, etc.), public halls and assembly rooms is prohibited, under penalty provided for violation of rules and regulations of the Board of Health." This action is in line with public health regulations adopted in progressive cities throughout the country. Copies have been posted by the street railroad company in all its cars and by proprietors of public halls in various instances, and have brought a fair degree of good result.

Among the important questions demanding the earnest consideration of the city government, none is of greater importance or demands earlier consideration than that of proper and effective disposal of the sewage of the city. Certain sections of the city demand sewage facilities at an early date, or the city will be affected with an epidemic of disease that will prove vastly more expensive than the construction of the necessary sewers to relieve the congested district.

The accumulation of sewage and offensive matter in the Nashua River still continues, and the pollution grows greater each year, and will soon be a standing menace to the health of this community, and the board feels that some measures ought to be adopted toward carrying much of the sewage matter of the city to a point beyond the thickly settled portion of the community. The board deems this of sufficient importance to demand your early consideration, to the end that the means will be devised toward a proper remedy. We would ask the city government that a committee be appointed to take into consideration the matter of a sewerage system for the city, a main sewer of sufficient size with properly connecting branches to carry the sewage below the city proper, and report upon the same at an early date, to the end that the sewers hereafter constructed may be connected and carried into a common system.

Owing to the growth of the bacteriological work of the board, we would ask that a room be assigned us and that an appropriation be made for properly fitting up and conducting the same. This plan has already been adopted in several cities in the State.

Together with other boards throughout the State, this board has in view the bringing under the supervision of their department the sources of milk supply, including premises outside of the city as well as inside, where milk is produced for consumption in Fitchburg. The plan contemplated would be an inspection of all such premises with a view to ascertaining the conditions existing, and to make the issuing of licenses dependent on such conditions.

The board has taken a radical departure from previous methods in the matter of fumigation and disinfection. The new disinfectant, formaldehyde, has been adopted by the board, and is used in all cases of scarlet-fever, diphtheria and membranous croup with good results. This has necessitated the doing of the entire work of fumigation by the agents of the board, and as a consequence considerable extra expense has been entailed, but with the result of the work being done properly, which has seldom been the case previous to this time. In addition to this, the board has distributed in all cases liquid disinfectants, as it has been found by experience that in many cases the same were not freely used when not provided by the board. From its own work and the many reports received, the board is perfectly satisfied of the virtues and effectiveness of formaldehyde as a disinfectant; but it is of the opinion that many improvements are yet to be made in machines before the best results can be obtained.

The board must always be at more or less disadvantage until a contagious disease hospital or hospital ward is provided. It is safe to say that good isolation is impossible in at least one-half of the cases where it is needed the most, and therefore a contagious disease hospital is imperatively demanded, and we ask that one be provided at the earliest moment. Most cases occur in families whose means and room are too limited to allow of what is desired in this direction. In many cases there are several members of the family who are employed in mills and in factories where large numbers of people are congregated together in one room; under such conditions the danger of contagion is much increased unless the said members are debarred from employment during the continuance of the case. The board has endeavored to enforce this as a regulation, but it nearly always works hardship, and it is a question if wage-earners can or ought to be thus deprived of their means of support without compensation from the authority depriving them. With a contagious disease hospital or ward this difficulty could be avoided, beside removing the danger of contagion.

Franklin.

The number of complaints brought before the board has been less than usual.

A considerable improvement in the sanitary condition of the town has been undertaken in the clearing and deepening of Mine Brook.

The people of Franklin are again reminded that Franklin can be made a healthful town to live in only by securing some efficient system of sewerage. Malarial diseases are prevalent in every part of the town. Conditions exist which are a perpetual menace to the public health, and no endeavor short of good sewerage can remove them.

Gardner.

One feature that the board has given particular attention to is the doing away with surface drainage of cesspools and other filthy matter.

An effort has been made to influence the milkmen to keep their barns as clean as possible, and it is hoped that the effort may continue, and better ventilation and sanitary conditions generally will be the aim of all the milk producers.

Having been informed that formaldehyde had been used with good success in Boston and other large places, the board decided to purchase it for the use of public buildings and private houses. It has been used several times, with perfectly satisfactory results. Not one case has been reported from any house where it has been used.

Great Barrington.

We are pleased to report that during our official year there has been but one case of infectious disease in the town. Early in the spring of 1897 a case of scarlet fever was reported in the village of Housatonic. In this instance the house was promptly quarantined and was kept under strict quarantine regulations until the patient had entirely recovered. The house and its contents were then thoroughly fumigated, and no more cases of the fever occurred.

It is of the greatest importance from the business stand-point, as well as from every other, that in this town good sanitary conditions be secured and preserved. A town which is growing in favor among summer residents cannot be too careful that its attractions shall not be marred by any kind of nuisance which not only offends the senses, but not infrequently causes disease.

Haverhill.

The death rate is the lowest of any year during which the board of health has collated statistics. The whole number of deaths, not including still-births, is 517, 41 less than for the year 1896, and making the rate for the year 14.11 to the thousand of population.

Of typhoid fever, as in the preceding year, we have had nearly three times the average number of cases of the last twelve years. There were in all 125 cases, nearly 100 of which occurred epidemically from about the fifth of August to near the close of the year, and were due, in the opinion of the board, to one general source of infection.

As soon as the board felt that a sufficient number of cases had occurred to justify conclusions, it asked the board of water commissioners for a conference, which was readily granted. It was unequivocally stated that, in the opinion of the board of health, the polluted water of Crystal Lake was directly responsible for the prevalence of typhoid fever. It was also stated that, although the board disliked to seem to create alarm in the mind of the public, it would feel compelled, unless the epidemic abated, to warn the takers of Crystal Lake water to boil it before using it for drinking. The epidemic gradually abated, and the warning was unnecessary.

Holyoke.

The question of garbage disposal is the most serious question with which the board of health has to deal. Every year it becomes more perplexing, owing to the fact that dumping grounds are more scarce and more remote from the business centre of the city. During the year this department has been obliged to haul garbage to places of deposit in the suburbs, at an expense far beyond the limits of economy.

Hyde Park.

In the handling of contagious diseases improvement has been made in the prevention of contagion to a great extent, the use of formalin as a disinfectant having been adopted and fumigation being done in a thorough and effective manner by this method.

Ipswich.

The small death rate from diphtheria is no doubt due to the new remedy, antitoxin, which the physicians have so generally used in their treatment of this disease.

Lee.

All the typhoid fever cases were in the same house, and, in the opinion of the medical attendant, were caused by the use of water from a well recently sunk in gravelly soil contaminated from a long-used privy.

Leominster.

There are two nuisances which have existed during the past year which must be looked after sharply and dispensed with before the warm weather comes on. One is the pollution of a small stream running through the centre of the town by the occupants of the factories and houses situated on

its banks. Although measures have been taken to stop the pollution of this stream, it is evident that a strict compliance with these requests has not yet been adopted. Unless in the immediate future these requests are heeded and complied with, more stringent measures will have to be adopted and enforced, in order that this contamination and source of danger to the health of the town may cease. The other nuisance referred to, which exists at times, is the tendency of all pond owners, during the warmer weather, to draw down their ponds and allow them to so remain for several days. The board recognizes the fact that it is necessary at times to draw down these ponds for purposes of repair, but at the same time would strongly and emphatically urge upon these owners the great necessity and absolute importance of being as expeditious as possible at such times, and to permit these ponds to remain drawn off for as brief a time only as is absolutely necessary.

The town is to be congratulated on its water supply, as we consider no town in the State has a better or purer water to drink than do the inhabitants of Leominster.

Lowell.

The cremator has rounded out the five years of its guaranteed service, and its work for the past year has justified the promises made for it. Cremation is now regarded as the best and most effective method of disposing of the city's garbage. It has cost the city of Lowell money to adopt the principle, and it is gratifying to have the expenditure justify the wisdom that made it. Lowell as a pioneer in this most sanitary method cannot very well go back to the old method of disposing of the garbage among the farmers, ostensibly to be fed to pigs, but more frequently to be fed to milch cows. A lack of means is alone responsible for the closing of the cremator during the winter and the distribution of swill among the farmers.

Cost of burning garbage, 1894,		$5,742 69
Cost of burning garbage, 1895,		3,662 53
Cost of burning garbage, 1896,		3,343 34
Cost of burning garbage, 1897,		2,612 07
Saving in 1897 of	$731.27.	
Lowest week's cost per ton, 1894,		$1 02
Lowest week's cost per ton, 1895,		81
Lowest week's cost per ton, 1896,		68
Lowest week's cost per ton, 1897,		41

During the year 1897 30,432 loads of ashes were removed from the houses and stores to the various dumping grounds in use.

The board completed the inspection of bakeries begun in 1896 under the provisions of chapter 418 of the Acts and Resolves of the Legislature of 1896. Every bakehouse was inspected, and orders were given for changes

or improvements in them, in order to have them comply with the law. A prompt compliance was manifested in every case. Of the seventy-five bakeries examined, five were found unfit for use as such; these were closed.

The need of medical inspection of the scholars in daily attendance at schools has been felt during the year. In December, on account of the prevalence of diphtheria in a certain locality, the board sent two physicians into the schools in that district, and had a general inspection of all the scholars in those schools made. The idea of medical inspection of the schools is no longer to be classed as an experiment. The board would strongly recommend that a corps of medical inspectors be appointed for the purpose of inspecting the schools daily, as well as all cases of contagion reported to the health department.

In the early part of 1897 plans were made for a special effort to reduce the large number of deaths that occur annually among children, particularly those deaths due to cholera infantum. Encouraged by the favorable reports on the use of pasteurized milk against infant mortality in the city of New York, an attempt was made to establish a plant in Lowell suitable for supplying sufficient pasteurized milk at a cost within the reach of all.

The board also formulated a scheme for taking sick children under five years of age into the country, away from the crowded surroundings of many of the poorer districts of our city. The board of health, as a part of the municipal body, was restricted by law from carrying out the arrangements made, but the members of the board, by associating themselves with a committee of three from the Day Nursery Association, were able to successfully accomplish the desired results without any expense or legal liability to the city.

The number of deaths from cholera infantum in the third quarter of 1897, July, August and September was 159, as compared to 185, 181, 179, 213 and 181 for the same months in the preceding five years. The total number of deaths among children under five years of age was, for 1897, 778, compared to 844, 788, 751, 936 and 928 for the preceding years. Thus it will be seen that during the year 1897 we had fewer deaths among children, especially from cholera infantum, than in any of the previous years. This is gratifying, when we consider that nearly half of all the deaths in Lowell in any year are children under five years of age.

With the view of learning if there were any condition or state of living among the operatives which could account for their comparative susceptibility to typhoid fever, the board of health asked for a conference of the water board and the agents of our mills with the health department. A full and open discussion of the question of the water supply for Lowell and its relation to typhoid fever took place.

It was learned that all the mills, with one exception, the Tremont and Suffolk, used canal water drawn directly from the pipes at the sinks. Some of the mills have wells from which their supply of drinking water is

drawn, and one is piped for city water; yet it was the testimony of all that the operatives will use the canal water direct from the faucet, although in all the mills there are notices warning them of its dangers. It was the unanimous opinion that the use of canal water for drinking purposes should be stopped at any cost, and there was a feeling of hearty co-operation by all to that end. It was decided that a thorough investigation of every case of typhoid fever should be carried on for one year, and in the mean time a sign labelled "Poison" should be placed over every faucet in the mills from which canal water is drawn.

Twelve cases of cerebro-spinal meningitis occurred in Lowell, a larger number than had ever appeared at any one time. Owing to the fact that the history of the cases pointed strongly to the contagious character of the type, and also to the fact that other cities in the State were having a large number of cases at the same time, the board voted to add this disease to the list of contagious and infectious diseases requiring notification from the attending physician.

Within the past three months the application of Widal's test has added an important branch to our laboratory work.

Contagious Hospital. — The necessity for such a hospital in this city was forcibly demonstrated during October, November and December of 1897, when we had practically an epidemic of scarlet fever and diphtheria. The board is of the opinion that, could the first cases have been properly isolated, the disease would have been stamped out before it had gained such headway. To try to isolate patients sick with scarlet fever and diphtheria in tenement blocks is practically impossible.

Lynn.

During the past year the board has ceased to use the sulphur process of disinfection, and has adopted the use of formaldehyde gas as a germicidal agent and disinfectant.

We very respectfully recommend that the city government license but one slaughter house for cattle and swine in the city.

The fifty-four bakeries in this city have been inspected, and printed cards containing chapter 418, Acts of 1896, have been posted therein, as required by the statute.

The hospital for contagious diseases has the past year, 1897, again justified its existence by having admitted to it 99 patients, 93 cases of diphtheria and 6 cases of scarlet-fever, of which 90 were discharged cured, 8 died, and 2 remained Jan. 1, 1898. This is a death rate of 8.60 per cent. for diphtheria and none for scarlet fever.

During the year twenty-eight milk dealers have been brought into court and fined.

Three thousand one hundred and seventy-eight animals have been inspected. Seven hundred and seventy-nine have been tested with tuberculin,

and of these sixty have been condemned and killed. The great decrease in the number of diseased animals tends to show the justice of the methods which have been pursued in this direction during the past.

Malden.

The general health of the community has been better than for some years previously, notwithstanding that there have been more diseases of a contagious nature reported. Measles were extremely prevalent in various sections of the city during the early part of the year; and the carelessness of parties interested called for action on the part of the board. The fact that a large part of the people consider this disease harmless, and that every child must sooner or later fall a prey to its ravages, accounts in a large degree for the great number of cases that were reported to the board. It is to be believed that not more than seventy-five per cent. of the cases that existed were reported. It is the sheerest nonsense to suppose that every child must be a victim to the diseases of childhood, and that the sooner they are exposed to these terrors, the better.

Early in the year the board adopted formaldehyde as the disinfecting medium, and made it compulsory that an agent of the board should personally superintend the disinfection of all apartments where diphtheria or scarlet fever had existed. This method has given very general satisfaction.

The board would once more urge for your thoughtful consideration the need of a contagious ward or hospital.

In compliance with the law, the board personally inspected all bakeries within the city limits, and ordered such changes to be made therein as seemed warranted and best for the public good.

Marlborough.

The board this year, as in the past five years, urges upon the city the necessity of establishing a system of sewerage in the territory adjacent to Lake Williams. The cesspools on the watershed of the lake have been attended to with the utmost vigilance, but it is almost impossible to stop some of the impurities from entering the lake.

During July and August there appeared an epidemic of dysentery, which, from the number of cases, the character of symptoms and the mortality, was apparently of a different nature from the occasional cases of cholera morbus and summer diarrhœa seen in recent years. The physicians of the city were agreed that the cases met with at this time were exceedingly severe, and yielded slowly to treatment. There were in all about 145 cases; the shortest duration being five days, the longest five weeks; average duration thirteen days, with 16 deaths. The cases were pretty evenly distributed in all parts of the city, with the exception of French Hill. The board was unable to discover any special cause for the disease.

The board, realizing the inefficiency of fumigating with sulphur or any of the methods heretofore used in disinfecting in cases of contagious diseases, has purchased a "Sanitary formaldehyde regenerator."

Medford.

The board wishes to repeat its statements in regard to the urgent need of early and carefully made microscopical examinations in cases suspected to be diphtheritic.

Melrose.

But for the flood of measles, which was altogether exceptional, our record of contagious diseases would have been very small.

The mortality from diphtheria has fortunately been very small, a result doubtless due in large part to the general and timely use of antitoxin. The general testimony of our physicians is heartily in favor of its employment. One physician reports its use in thirty consecutive cases during the years since its introduction, and without a single fatal result.

The board of health has felt seriously the urgent necessity of having the test for diphtheria made with the least possible delay, and therefore has been endeavoring to have it done here in Melrose. The efforts made by the board to secure this desirable result have not as yet been successful, but the plan now being prosecuted will, it is hoped, secure a favorable issue in the early spring. In the gratuitous examination which the State Board makes of the secretions of suspected consumption, the lapse of a few days involves usually no unfavorable results.

The milk supply to the town has not been overlooked by the board.

The swine-keeping business has been under observation during the year.

The slaughtering of animals has been heretofore conducted in an irresponsible manner, and at times with unseemly exposure. The board will hereafter control it.

Natick.

The board is more than ever convinced of the wisdom of the order requiring bacteriological tests of the throat in suspected cases of diphtheria. It is the only means by which a true diagnosis in such cases can be made; and where a negative result is given, all anxiety and neighborhood excitement is at an end.

New Bedford.

There has been no serious epidemic during the past year. It is also pleasing to record the fact that the increase in the number of contagious and infectious diseases, as compared with the year previous, is not greater than what might be expected from an increase in population. Every case reported at this office is made the subject of a special investigation on the part of the medical inspector of the board. By this method of procedure we are enabled to control pupils who otherwise might attend the public

schools. It is because of this care in looking after every case reported that the board has not been ready to adopt a system of medical inspection for the public schools, believing that the time has not arrived for such a lavish expenditure of money.

The culture method of assisting in making the diagnosis of cases of diphtheria is very generally employed by the physicians of the city. Formerly mild cases were not reported as diphtheria, but the culture method eliminates any doubt, and it is gratifying to see how readily the physicians have taken to its use. Tubes for the purpose are furnished by the State Board of Health, and can always be procured at this office upon application.

Within the past two months we have kept a complete record of all such tests. In most cases quarantine is removed only upon a negative result.

Newton.

In accordance with the provisions of chapter 418, Acts of 1896, all buildings occupied as biscuit, bread or cake bakeries have been inspected, and copies of the above statute posted therein.

The growing importance of the better protection of the milk supply was fully realized by the board, and during the summer a preliminary inspection was made of the milk farms. The conditions found fully justified the need of legislative authority to compel radical reforms in the methods of housing and cleaning of cattle, the handling and storage of manure, and the handling of the milk from the time it leaves the cow until it is delivered to the consumer.

The keeping of swine upon the premises used for the production of milk for sale was deemed by the board to be a serious evil, and orders were accordingly issued prohibiting the keeping of swine upon all such places after Dec. 1, 1897. The board has also required several parties to reduce the number of cattle kept in certain restricted quarters, in order that each animal might receive the proper amount of air.

The general health of the city has been good during the past year, and the death rate for the year has fallen to 16.20, a marked improvement over 1896.

The board has considered it wise to move slowly in acquiring apparatus for generating formaldehyde, lest it should be left with expensive apparatus upon its hands which larger experience might show to be less efficient than was supposed, and for this reason it has not increased its stock of generators.

Some little complaint has been made of delay in disinfection, due to the fact that the number of generators in use is limited; but this is only a temporary inconvenience, and before the close of another year it is hoped that the number of efficient generators on hand will be sufficient to meet all calls without delay.

During July and August, through the kindness of Prof. S. Burrage of Purdue University, Lafayette, Ind., the board was enabled to make some

interesting and valuable experiments at the Newton Hospital as to the value of formaldehyde as a germicide. The tests extended over a period of about six weeks, and the results have been made the subject of a paper by Professor Burrage, which is too long to be included in this report, but a short résumé of the subject will be of interest.

The original intention was to determine what form of formaldehyde generator was the most efficient and best adapted for use by the average unskilled operator.

Four different styles of generators were used in the tests, two producing the gas from the 40 per cent. solution, and two producing it directly from wood alcohol.

The results taken as a whole showed that formaldehyde is not as fatal to disease germs as is generally claimed, at least when the exposure is for so short a period as six hours.

There was no great difference in the efficiency of the different forms of generator, the results being practically the same with each.

A number of tests were made with each generator, in order to have as large an amount of information as possible upon which to base conclusions.

No record was kept of the amount of gas evolved by each generator, although the same amount of solution (about one quart) was used in each of the first form, and about one litre of alcohol was consumed by each of the second form. This would give, approximately, sixteen ounces of formalin and five hundred cubic centimeters of alcohol to one thousand cubic feet.

The practical conclusion to be drawn from these tests is that, while formaldehyde remains the most practical gaseous disinfectant which we possess, a number of elements must be taken into account in order to obtain satisfactory results. The length of time of the exposure, the amount of gas used to each one thousand cubic feet, and the care with which crevices are closed to prevent the diffusion of the gas, are all of importance and must be taken into consideration.

After the tests with formaldehyde had been finished, dry sulphur fumes were used under the same conditions, with the result that it was shown that they had absolutely no effect upon the test cultures, those which were exposed to its action growing as rapidly and luxuriantly as the controls.

While the city is well equipped for house and room disinfection by the use of formaldehyde, it is still without the proper method of sterilizing the more bulky of household furniture, such as carpets, mattresses, etc., into the substance of which the formaldehyde does not penetrate. For this purpose a steam disinfecting plant is needed, and it is with great satisfaction that the board is able to report that such a plant will be erected in the near future, in connection with the proposed new heating and power plant for the municipal buildings. The sterilizing chamber will be of the most approved construction, and large enough to take the most bulky articles, being seven by five feet.

A new method of school inspection was inaugurated in September, by which the scholars are examined at the reopening of the schools after vacation. It is intended to have three such inspections annually; viz., at the reopening of schools in September, after the Christmas vacation and after the spring recess. It is hoped that by this means any unsuspected cases of disease which may have occurred during the recess may be detected, and so prevent as far as possible any chance of the infection of the other pupils.

Twice in previous years outbreaks of scarlet-fever have been traced to children who, having had the disease during vacation, came to school while desquamating, and the board aims by this means to prevent a recurrence.

The board has continued the practice of furnishing antitoxin to physicians whenever they apply for it, and through the courtesy of the State Board of Health has been able to keep a supply on hand ready for emergencies. It has also furnished antitoxin to the hospital whenever requested to do so.

North Adams.

Chapter 418 of the Acts of Massachusetts of 1896, entitled "An Act relative to bakeries and persons employed therein," has for its object the cleanliness of bakeries and rooms in which "the manufactured flour or meal food products shall be kept," and the board of health is charged with the enforcement of its provisions. In conformity therewith our board has inspected the various bakeries in this city, ordered such changes as it considered necessary, and posted a copy of the act in each place as the law requires.

An ordinance was passed by the city council and approved May 8, relating to ice for domestic uses, in which all persons intending to sell ice in this city are required to give notice of such intention to the board of health, stating the source from which such ice is taken. The board of health shall make analyses of the ice, and shall also examine into the source from which it is taken. A copy of the result of such examination, containing an adjudication by the board upon the purity of the ice and its sources, shall then be filed with the city clerk, and no person shall sell any ice for domestic use in this city that has been declared impure. In pursuance of this ordinance, the board of health made a careful examination of all sources from which ice was taken to be sold in North Adams. It may be well to state here that our board took the ground that no ice is fit for domestic use unless made from water of sufficient purity for drinking purposes.

The board of health of the city of North Adams, acting under chapter 16 of the revised ordinances, has caused to be examined the ice and the sources of supply of ice which is offered for sale and distribution in this city for domestic purposes, and has taken samples and caused careful and proper analyses of the same to be made, as appears from the report of Mr. A. T. Hopkins, herewith attached and made part of our report.

We find, and so adjudicate, that the ponds situate in North Adams, and commonly known as the "Witt Ponds," on State Street, the "Lower Pond," near Flagg's Meadow, and the pond lying between the track of the Hoosac Valley Street Railway Company and the Fitchburg Railroad west of Blackinton, are unfit as sources of ice supply, and the ice from each and all of such ponds is impure and unfit for domestic use. We also find and adjudicate that the pond on Hudson Brook, as it now is, with the nuisances now existing on said brook, is an unfit source of ice supply, and that the ice from such pond, until such nuisances are removed, is impure and unfit for domestic use.

Northampton.

Diphtheria has been endemic in the western wards of the city during most of the year. Of the 125 cases reported, 21 resulted fatally. Most of the deaths were caused by the laryngeal form of the disease. Antitoxin has been very generally employed in the treatment of the cases and with very satisfactory results. The board has endeavored to prevent the spread of the disease by quarantining the houses, and by improving the surface drainage and the plumbing of the houses in the districts where the disease most prevailed.

The board has not, in every instance, had the hearty coöperation of the individuals in infected houses, which would assist materially in preventing the spread of the disease. Instances have occurred where the quarantine rules were disregarded utterly.

Norwood.

We believe that it is possible to materially lessen the spread of disease, particularly among children, if parents, school committee and teachers will more rigidly conform to the provisions of the laws respecting school attendance of children suffering with contagious disease.

Co-operation of parents and school committee in enforcing the provisions of the laws is earnestly desired by the board of health.

The keeping of swine is prohibited, excepting to those who receive a permit from the board of health, which must be renewed annually.

The board has one authorized agent to collect swill, and all persons having such to dispose of are requested to employ the agent of the board, whose services may be had free of cost by notifying the board. All other persons engaged in transporting offal through the public streets are doing it in violation of the law.

Pittsfield.

With the introduction of disinfection by formalin, it was decided that the board purchase for the use of the city a proper appliance for disinfection. A member of the board went to New York and inspected the working of the same. An agent was appointed and instructed in the proper

use of the same, he having disinfected in all, up to date, forty-five tenements, and in no case has there been a return of the disease where such infection has been done by our agent.

During the past year the board has supplied antitoxin to nearly all cases of diphtheria occurring in town, with the happiest results. Out of 112 cases reported, there were only 7 deaths. Of these fatal cases, antitoxin was not used in 4, and in the other 3 cases administered too late to be of service.

Provincetown.

The sanitary condition of our town appears to be much improved, owing largely to the co-operation of the majority of the citizens who have kindly aided us in our work. About eight hundred houses have been inspected, and the change for the better is very marked. The health of the town is no doubt due to the general cleanliness, and it is noticeable that scarlet and typhoid fevers have greatly decreased of late years.

Salem.

Concerning children's diseases, particularly diphtheria, the board would impress upon parents the importance of calling a physician upon first symptoms appearing.

Contagious Hospital. — This subject is one yet unsettled, and is a matter rendered necessary both by the statutes and the wants of the city. Had Salem possessed one last year, money could have been saved, better opportunities afforded to save human lives, and possible quarantine annoyances obviated.

Since the subsidence of the epidemic of diphtheria, which existed in the fall of 1896 and the spring of the present year, the health of the city as a whole has been unusually good, cases of contagious disease being exceptionally rare.

Somerville.

Number of nuisances abated, ... 989

Glanders. — Twenty-three cases of glanders have occurred during the year. Prompt action was taken in every case, and the horses have been killed. We renew our request sent to the committee on highways last year, that the committee use great care to have the watering troughs cleaned out occasionally, in order to prevent the spread of this disease.

Springfield.

I can learn of no case in which the diphtheria antitoxin failed to do good when used promptly, although several died suddenly of heart paralysis some time after apparent recovery. The State Board of Health continues to furnish the antitoxin for use in cases where its purchase would be a hardship. It is now possible to determine the period during which per-

sons who have had diphtheria may transmit the disease to others, and it seems wise to demand that such persons, and especially school children, should be declared free from the bacillus of diphtheria before being received into schools or associating with healthy individuals.

A hospital for the reception of persons suffering from diphtheria, scarlet fever and some minor contagious diseases is much needed.

Stoneham.

We have used all means to prevent the spreading of contagious diseases, and where complaints have been made of premises not in a sanitary condition they have been promptly inspected and the nuisances abated.

Taunton.

In common with many other boards of health throughout the Commonwealth, our board has largely abolished fumigating by sulphur, a method crude, uncertain and disagreeable alike to the board and to the householders. In place of this, we now disinfect infected houses by means of formaldehyde gas.

Wakefield.

One of the first things that was thrust upon our attention was the bad condition of the pond near the Centre depot. The board has caused notices to be served upon twenty-six parties entering the stream which runs into the pond, ordering them to take the pipe out of the stream. Nearly all of these notices have been complied with.

A bad condition of things exists in the more thickly settled portions of our town, on account of the frequent filling and overflowing of cesspools; and your board is constantly called upon to pass and enforce regulations that are a hardship upon the particular persons affected.

Our physicians have given very favorable reports on the diphtheria antitoxin, expressing the opinion that it has materially reduced the death rate from this dread disease, and that cases have yielded to its influence that in their opinion were not amenable to former methods of treatment.

Waltham.

On June 15, 1897, certain rules and regulations deemed reasonable and proper, with reference to the milk supply, after careful consideration, were adopted and printed in the city papers; at the same time a circular letter was addressed to those milk dealers whose supply was purchased from dairies, requesting a complete list of their dairies, thus showing the sources of the milk supply of Waltham. These requests were very promptly and generally answered. Copies of the rules and regulations of this board were sent to the milk dealers and dairies of the city. At the same time a careful inspection of these dairies and milk dealers was made by our agent,

and licenses granted to those persons favorably reported by the agent. It is pleasant in this connection to record the very hearty co-operation of all parties interested in the milk supply question, to aid this board in its work and to meet all the requirements of the regulations. The importance of the question, affecting, as it does, the public health, was not lost in the question of some slight pecuniary disadvantage to the person affected. While our work has been done as systematically and carefully as our means permitted, still it is but a beginning. Regular, rigid and frequent inspections should be made, in order that the dairies may be maintained in the proper sanitary condition and the milk supply kept pure.

The general health of the city has been good. It was decided to add measles to the list of contagious diseases required to be reported to the board by the physicians of the city, and the school board required to instruct its teachers not to permit any children so afflicted to attend school. The school board was further requested to require its teachers not to allow children suffering with whooping-cough to attend the schools. These requests have been carefully observed.

Ware.

The exact diagnosis of the character of inflammations affecting the throat is being furthered by the provisions which are made by the State Board of Health for the making of cultures and the microscopical examination of the germ growth obtained from the throats of individuals affected. The expense of this work is borne by the State Board. Culture tubes are kept constantly on hand here, ready for the use of physicians in having the infectious character of cases of throat trouble determined. The diphtheria germ may be present in cases where the individual is mildly affected with sickness; but examination of the germ growths, obtained by use of culture materials, reveals the infectious germs and indicates that precautionary measures should be taken to prevent the spread of diphtheria. By recognition of mild cases of diphtheria, and taking means early and constantly for destroying, as far as possible, the infectious material given off by those having this disease, very much may be done to prevent its spread and the occurrence perhaps of fatal forms of this disease in others. Antitoxin for diphtheria is used here freely and with very good effect. In families where several are brought in close association with a case of diphtheria of more than mild character, the use of antitoxin is frequently made as a preventive before diphtheria really appears in the throats of those thus exposed. Such use was made of antitoxin here during the year.

Warren.

The culture-tubes mentioned in the last year's report, which are furnished by the State Board of Health, free of expense to the town, have been of great service to the physicians and to the board of health during the past

year: to the physicians, in determining whether the cases of throat disease were diphtheria or not, thus placing themselves in a position to report their cases correctly, avoiding unnecessary quarantine; to the board of health, in determining the proper time for the release from quarantine.

The antitoxin was used before the results of culture examinations were received. The prompt use of the antitoxin was most satisfactory.

Wellesley.

Three of the cases of diphtheria were imported. A child who had recently had diphtheria at the City Hospital, Boston, was discharged, cured, after thorough disinfection, and came to Wellesley to recuperate, bringing with him a toy trumpet which he had used when first taken sick, but left at home when committed to the City Hospital. The daughter of the hostess used the trumpet to amuse the child, and was taken sick soon after; then the mother and a friend were attacked. All three were sent to the Newton Hospital, and the house was thoroughly disinfected. No new cases followed this outbreak.

Westfield.

One hundred and ten complaints of nuisances have been promptly attended to during the year.

The board has had excellent results with the fumigator for which the town made appropriation at a special meeting. Fumigation is accomplished much quicker and more thoroughly than with the old method of burning sulphur, and causes no damage to household furnishings.

Cattle inspector's report: —

Total number of places visited,	188
Total number of milk farms visited,	35
Total number of private farms visited,	78
Total number of horned stock inspected, about	1,200
Total number of swine inspected, about	380

Whitman.

One hundred and sixty complaints have been entered and attended to this year, and the routine work is gradually increasing.

Following is the report of the cattle inspector: —

Beef inspected at slaughter-houses,	11
Swine inspected at slaughter-houses,	217
Veal inspected at slaughter-houses,	91
Cattle examined in herds,	438
Cattle condemned in herds,	11
Swine examined,	50
Swine condemned,	6

Winchendon.

Diphtheria has been present in all parts of the town at intervals during the year. There were several instances where persons sick with diphtheria deliberately exposed others to the disease, fortunately no deaths resulting.

The question has arisen whether the board ought not to support a family when the wage earners are quarantined.

Winchester.

It is only a matter of a few years when the town will be compelled to adopt some different method for the disposal of its garbage. We propose to make an early investigation as to the methods prevailing in the surrounding towns, and, if one be found suitable to the needs of our town, we shall recommend its adoption.

There are 1,100 houses on the streets at present supplied with a sewer, and only 291 of them are connected.

Malarial diseases seem to be somewhat less than last year. Much time and no little expense has been required in the care of infected households. Fumigations are made with formaldehyde in all cases, and no fumigation is accepted (or restrictions removed) except when done by the board of health through its agent.

Worcester.

By order of the city council, the public bath-house, which was finished in July, was placed in charge of this department. It was opened for use July 20. Friday of each week was given to the women and girls, and subsequently every morning except Sunday, from 7 to 9, was added. This was to encourage quite a number of young women and girls who were anxious to learn to swim, but found it difficult when given but a single day each week. These girls deserved encouragement, too, for they took advantage of the opportunity, many of them attending each day before going to office or school. We earnestly recommend that the present house be given to the use of women and girls exclusively, and a new and perhaps larger house be built for men and boys.

Bacteriological Department. — The work of this department was very satisfactory during the year; 1,089 cultures were examined in all; 816 were first cultures, 278 of which were positive and 538 negative; 8 second cultures were positive where first were negative; 17 had no growth; 147 first cultures of convalescence were examined, 105 of which were negative and 42 positive. There were 41 second cultures of convalescence, 19 of which were positive and 22 were negative. Of the 24 third cultures, 7 were positive and 17 were negative. There were 9 fourth cultures, 3 positive and 6 negative; 3 fifth cultures were examined, 2 were found to be

negative and 1 positive. In one case of convalescence 8 cultures were taken, covering a period of 12 days after the membrane had disappeared, before a negative culture was obtained.

Glanders and Farcy. — The number of cases of this disease reported during the year was as follows: Glanders, 61; discharged 6, killed 55. It was decided to close for a time the public watering troughs, and to clean them thoroughly and disinfect them before letting on the water again.

Isolation Hospital. — Ninety-two cases were treated during the year; Seventy of these were diphtheria and the balance scarlet fever. Six cases of diphtheria died, a mortality of 8.57. There were no deaths from scarlet fever. When it is considered that many of these diphtheria patients were in a desperate condition when admitted, eighteen of them requiring intubation, with but two deaths, it is a cause for congratulation that the mortality is so low. The number of cases of diphtheria treated outside the hospital at their homes was 246, of which 49 died, a mortality of 19.91. When this is compared with the death rate at the hospital, 8.57, it must be apparent to all what an effect for good the sunny rooms, the pure air, the careful nursing and the free use of antitoxin at the hospital has upon the recovery of the patient. It must not be forgotten that all of this is but supplementary to the skill of the visiting staff and that of the resident physician, who have been unremitting in their care and have given unstintedly of their time to bring about these results. Great credit is also due to the nurses, whose unselfish devotion has contributed to the good results.

Several cases were received from among the pupils of the preparatory schools of the city, thus preventing possible epidemics and the consequent closing of the schools. Many other instances might be cited to show the need of a hospital of this kind, but in our opinion it is not necessary; every one must know how many homes there are in a large city like this without suitable accommodations for the care and treatment of contagious disease.

INDEX.